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THE ROCKEFELLER FOUNDATION

INTERNATIONAL HEALTH BOARD

SEVENTH ANNUAL REPORT
January 1, 1920—December 31, 1920

61 Broadway, New York, N. Y., U. S. A.
1921

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Public Health
Dr. Henry F. Vaughan
10-16-47

INTERNATIONAL HEALTH BOARD

Report of the General Director

To the President of the Rockefeller Foundation:

Sir:—

I have the honor to submit herewith my report as General Director of the International Health Board for the period January 1, 1920, to December 31, 1920.

Respectfully yours,

WICKLIFFE ROSE,
General Director.

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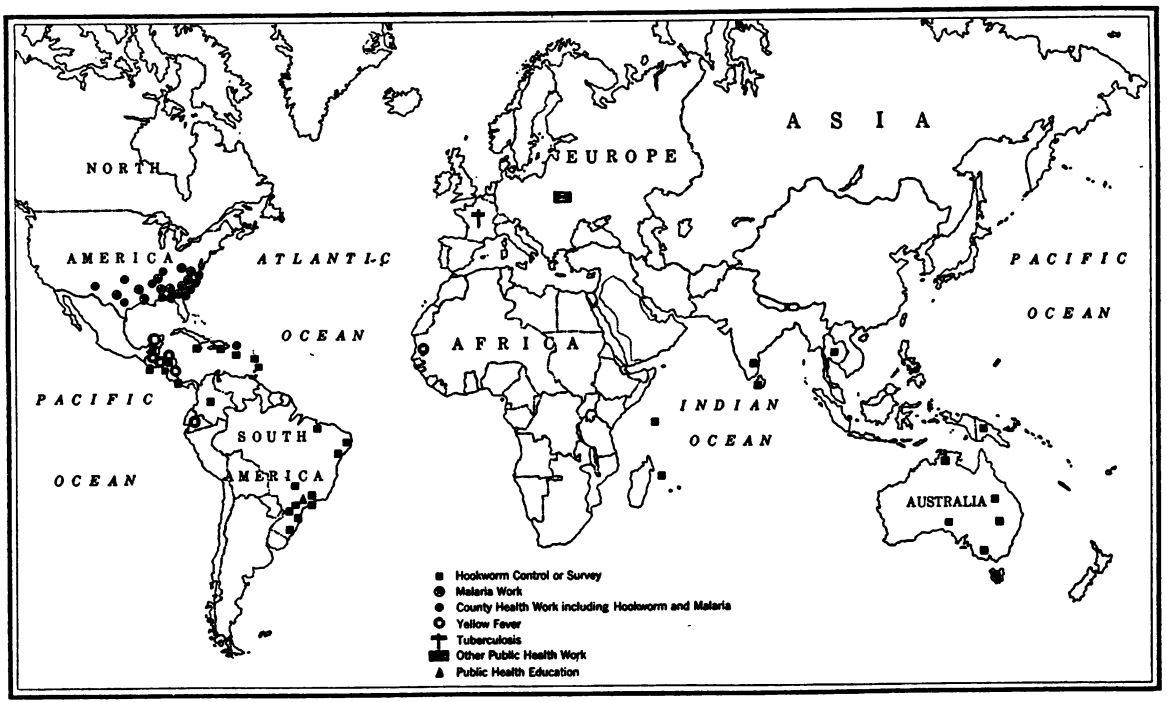


Fig. 1.—World map of activities of International Health Board during 1920

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INTERNATIONAL HEALTH BOARD

OFFICERS AND MEMBERS

GEORGE E. VINCENT, *Chairman*
WICKLIFFE ROSE, *General Director*
HERMANN M. BIGGS
WALLACE BUTTRICK
SIMON FLEXNER
FREDERICK T. GATES
WILLIAM C. GORGAS[1]
EDWIN O. JORDAN
STARR J. MURPHY[2]
JOHN D. ROCKEFELLER, JR.
WILLIAM T. SEDGWICK[3]
VICTOR C. VAUGHAN
WILLIAM H. WELCH

EDWIN R. EMBREE, *Secretary*

[1] Deceased July 4, 1920.
[2] Deceased April 4, 1921.
[3] Deceased January 25, 1921.

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PERSONNEL OF STAFFS DURING 1920[1]

ADMINISTRATIVE STAFF

WICKLIFFE ROSE, *General Director*

JOHN A. FERRELL, M.D., *Director for the United States*

VICTOR G. HEISER, M.D., *Director for the East*

HECTOR H. HOWARD, M.D., *Director for the West Indies*

L. W. HACKETT, M.D., *Associate Regional Director (for Brazil)*

ERNST C. MEYER, *Director of Surveys and Exhibits*

F. F. RUSSELL, M.D., *Director of Public Health Laboratory Service*

FIELD STAFF

HOOKWORM

AUSTRALIA	W. A. Sawyer
	S. M. Lambert[2]
BRAZIL	L. W. Hackett
	J. L. Hydrick
Bahia	F. L. Soper
Maranhão	F. L. Soper
Minas Geraes	G. K. Strode
Pernambuco	F. L. Soper
Rio Grande do Sul	Alan Gregg
Santa Catharina	Alan Gregg
CEYLON	W. P. Jacocks
	S. A. Winsor[2]
	C. H. Yeager
	G. G. Hampton
COLOMBIA	F. A. Miller

[1] Personnel employed by Government in co-operative work not listed.
[2] Special Staff Member.

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Costa Rica	Louis Schapiro J. E. Elmendorf, Jr.
Guatemala	E. I. Vaughn[1]
India (Madras Presidency; survey)	G. P. Paul
Jamaica	P. B. Gardner (resigned) B. E. Washburn J. W. Visher (resigned)
Mauritius (survey)	J. F. Kendrick
Nicaragua	D. M. Molloy
Panama	F. A. Miller (transferred to Colombia) F. C. Caldwell
Porto Rico (survey)	J. B. Grant
St. Lucia	R. B. Hill (acting)
Salvador	C. A. Bailey
Santo Domingo (survey)	J. B. Grant
Seychelles	J. F. Kendrick
Siam	M. E. Barnes
Trinidad	G. C. Payne R. B. Hill W. C. Hausheer

COUNTY HEALTH WORK IN UNITED STATES

Alabama	F. W. Dershimer A. L. McKay
Kansas	A. J. Warren
Kentucky	P. W. Covington

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New Mexico	D. B. Wilson F. H. Busby (resigned)
North Carolina	J. F. Docherty

MALARIA

Alabama	E. B. Johnson[1]
Arkansas	L. G. Hastings[1] William Ropes[1]
Louisiana	H. A. Taylor F. P. Gilbert[1] H. W. Green[1] F. E. Hulse[1] J. J. Mieldazis[1] L. J. Petritz
Mississippi	H. H. Howard C. C. Bass[1] J. L. Clarke[1]
Nicaragua	F. E. Hulse[1] D. M. Molloy
North Carolina	C. E. Buck[1]
Porto Rico	H. W. Green[1]
South Carolina	C. E. Buck[1]
Texas	E. H. Magoon[1] George Parker[1]
Virginia	E. H. Gage[1]

YELLOW FEVER

Yellow Fever Advisory Council[2]

Henry R. Carter, M.D., Assistant Surgeon General, United States Public Health Service

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[2] Not staff members; appointed to serve in an advisory capacity.

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Juan Guteras, M.D., Director of Public Health, Cuba
Joseph H. White, M.D., Assistant Surgeon General, United States Public Health Service
Hideyo Noguchi, M.D., Rockefeller Institute for Medical Research

YELLOW FEVER COMMISSION TO THE WEST COAST OF AFRICA

W. C. Gorgas,[1] *Chairman* (deceased)
R. E. Noble, Assistant Surgeon General, U. S. A.
Juan Guiteras, Director of Public Health, Cuba
Adrian Stokes, Assistant to Professor of Pathology, Trinity College, Dublin
A. E. Horn, West African Medical Service
W. F. Tytler, Member of Staff of Medical Research Council, London

MEXICO AND CENTRAL AMERICA	T. C. Lyster
ECUADOR	M. E. Connor
GUATEMALA	E. I. Vaughn[1] H. K. Marshall[1]
MEXICO	M. E. Connor B. W. Caldwell[1] I. J. Kligler Hideyo Noguchi
NICARAGUA	D. M. Molloy
SALVADOR	C. A. Bailey W. H. Davies[1]

TUBERCULOSIS

TUBERCULOSIS IN FRANCE

L. R. Williams,[1] *Director*
B. L. Wyatt[1]
S. M. Gunn[1]
Alexandre Bruno[1]
F. Elisabeth Crowell[1]

[1] Special Staff Member.

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SPECIAL

SCHOOL OF HYGIENE AND PUBLIC HEALTH, SÃO PAULO

S. T. Darling,[1] *Professor of Hygiene and Director of Laboratory*
W. G. Smillie, *Assistant Professor of Hygiene*
G. H. de Paulo Souza[1]
F. Borges Vieira[1]

PUBLIC HEALTH ADMINISTRATION, CZECHOSLOVAKIA

S. M. Gunn[1]

ON LEAVE

W. T. Burres
S. T. Darling[1]

AT HOME OFFICE

C. W. Wells (in charge of fellowships)

IN TRAINING

ALABAMA	A. L. McKay, M.D.
ARKANSAS	William Ropes[1]
COSTA RICA	J. E. Elmendorf, Jr.
LOUISIANA	F. E. Hulse[1] L. J. Petritz
MISSISSIPPI AND CEYLON	G. G. Hampton
MISSISSIPPI AND TRINIDAD	W. C. Hausheer
NEW MEXICO	F. H. Busby (resigned)
NORTH CAROLINA	J. F. Docherty
NORTH CAROLINA AND NEW MEXICO	D. B. Wilson

[1] Special Staff Member.

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OPERATIONS IN BRIEF

In the development of medicine emphasis is shifting from cure to prevention. Despite the fact of world-wide financial depression the year has been one of encouraging progress in public health. Government appropriations have been increased. New services involving continuing expenditures have been created and men are being trained for their administration. In response to the appeal of opportunities far in excess of its resources the Board has shared in an increasing number of projects in something more than fifty states and countries throughout the world.

Promoting Health in Many Lands

The Board brought its tuberculosis work in France well within sight of the completion of its transfer to the French by the end of 1922; took up the fight against yellow fever in Mexico; continued it in Guatemala, Honduras, Nicaragua, and Salvador; brought to successful conclusion the effort to free Guayaquil and Ecuador of the infection, and sent a yellow fever commission to West Africa to make a preliminary study of the situation; joined forces with federal, state, and local authorities in a series of demonstrations in

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malaria control by anti-mosquito measures in ten southern states; made a study of conditions in Argentina, Porto Rico, and Nicaragua with a view to extending its work in malaria control to tropical regions; pushed the fight against hookworm disease as a means of creating popular interest in public health under forty-two governments distributed over the more heavily infected regions; carried out a series of scientific studies yielding significant results in the fields of hookworm disease and malaria control; aided in the development of a rural county health service in twelve states; co-operated with the new ministry in developing public health administration in Czechoslovakia; assisted four state and national departments of health in establishing or further developing their public health laboratory service; and contributed toward the development of schools of hygiene at Prague and at São Paulo, Brazil, aided state boards of health in maintaining intensive short courses for workers in the service, and provided fellowships in public health for thirty-four selected students from ten countries. The object and effect of the effort in all countries have been to create popular sentiment in support of public health, to increase appropriations for health purposes, and to promote the development of permanent agencies for the control of disease, the cultivation of

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hygiene as a science, and the training of men for public health service.

Fighting Yellow Fever

Yellow fever, ignoring as it does political boundary lines and disturbing directly or indirectly the commerce of all nations, presents a particularly strong appeal for concerted effort on an international scale. During the year 1920 operations against the disease were in progress in all infected areas: on the east coast of Brazil; in Ecuador and Peru; in Guatemala, Honduras, Nicaragua, and Salvador; in Mexico; and in West Africa.

In Brazil. The infected area in Brazil is being steadily reduced. Extending in former

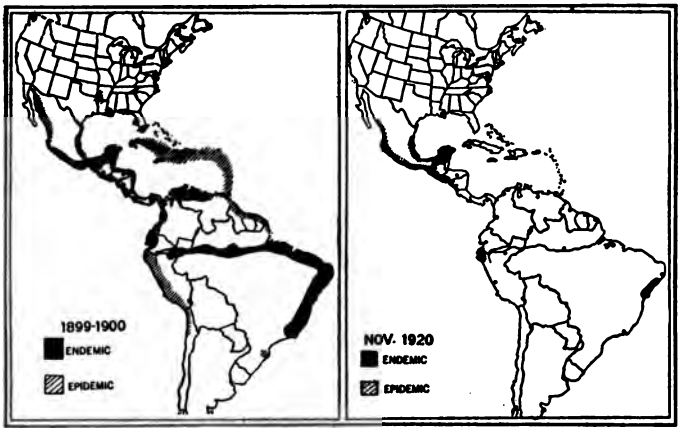


Fig. 2.—Result of twenty years' war on yellow fever. Few endemic or epidemic centers remain in the Western Hemisphere

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years from Rio de Janeiro along the east coast to the mouth of the Amazon river and up the Amazon valley to Iquitos in Peru, the disease is now confined to a narrow coastal strip from Pernambuco to Bahia. These two ports are suspected as endemic foci from which the infection spreads from time to time to the surrounding regions. A number of sporadic outbreaks early in the year were promptly extinguished. The situation would seem to call for an organized attack on the breeding places of the Stegomyia mosquito throughout the danger zone, with special concentration of effort on the two strategic centers: Pernambuco and Bahia. Operations are under the Brazilian National Department of Health, which has made available ample funds for the purpose.

In Ecuador. Yellow fever quarantine against Guayaquil, for more than seventy-five years a dreaded seed-bed of infection, has been lifted. Control measures were inaugurated in November, 1918. Effort was centered on the breeding places of the Stegomyia. As the mosquito index was lowered the case rate fell rapidly from eighty-eight in December, 1918, to two in May, 1919, since which time no case has been reported from Guayaquil or Ecuador. After more than a year of continued mosquito control dating from the last reported case of yellow fever, Gov-

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Fig. 3.—The late Major General William Crawford Gorgas. At the time of his death General Gorgas was Director of the Yellow Fever Commission of the International Health Board

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A TRIBUTE TO GENERAL GORGAS

By William H. Welch, M.D.

The following minute from the pen of Dr. William H. Welch was incorporated in the records of the International Health Board at its meeting on May 24, 1921:

Major General William Crawford Gorgas, a member of the International Health Board and the Director of its Yellow Fever Commission, died in London July 4, 1920, while on his way to the west coast of Africa to investigate the prevalence and importance of yellow fever in that region.

General Gorgas, by the conquest of yellow fever in Havana and the control of this and other pestilential diseases on the isthmus of Panama, had won world-wide recognition as a sanitary administrator. American and European countries alike sought his advice and services for the control of endemic and epidemic diseases. One of the most important of his foreign missions was to the Transvaal, where the measures he recommended resulted in markedly reducing the high mortality rate of pneumonia.

In January, 1914, General Gorgas became Surgeon General of the United States Army, and in 1915, in recognition of his work in sanitating the Canal Zone, he was created Major General by special act of Congress. Throughout the period of the World War he served as Surgeon General of the United States Army. The confidence reposed in him by the army, the medical profession, and the general public did much to enhance the value of his services in protecting the health of the American troops.

Years before his death his investigations and experiences with yellow fever had convinced him that in the Western Hemisphere the disease was kept alive by its prevalence in a few endemic foci. By means of a successful attack on the disease in these foci he considered it feasible to eliminate the infection from the New World. The stamping out of the disease in Guayaquil, and the encouraging prospect of controlling the infection in other parts of South America and in Central America, fully justify this faith of General Gorgas.

It is not too much to state that the results accomplished through the administrative genius of Gorgas, coupled with the scientific discoveries of others—notably those of Walter Reed and his colleagues on the United States Army Yellow Fever Commission—have repaid many times over all the money that has been expended for the support of scientific research. Their work has resulted in saving untold thousands of human lives and much treasure, in protecting the American sea-coasts from the invasion of a dreadful scourge, in the construction of the Isthmian Canal through a pestilential zone transformed into one of the most healthful on the globe, and in reclaiming for civilization many pest-ridden regions in tropical countries throughout the world.

The genial, kindly qualities of General Gorgas endeared him to all his associates. To his colleagues on the Board the memory of him and of his achievements will always remain a cherished inspiration.

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ernment declared the country free of infection and on December 1 the Board's representative was withdrawn. The local authorities are continuing operations as a precaution against the re-introduction of infection from Peru.

In Peru. Early in the year 1919 an extensive epidemic of yellow fever broke out in the department of Piura, just across the Ecuadorian border in northern Peru, and in twelve months had spread unchecked over a considerable area. The epidemic numbered more than 3,000 cases, with from 500 to 600 deaths. Mosquito control undertaken by Government in 1920 and carried out under the direction of Dr. Henry R. Carter, of the United States Public Health Service, resulted in the epidemic being promptly suppressed. Dr. Noguchi, of the Rockefeller Institute for Medical Research, visited the region during the outbreak and further confirmed his earlier findings in Guayaquil and Mexico by isolating from the blood of yellow fever patients the *Leptospira icteroides*.

Before the infection had been stamped out in Piura it had been carried into the department of Lambayeque to the south and was not discovered until it had again spread over a considerable region. Late reports indicate that it is still making headway. In response to invitation by Government the Board has contributed toward

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the maintenance of control measures which are now being organized by Dr. Henry Hanson under the National Department of Health.

In Mexico and Central America. Merida, Yucatan, has been regarded for years as an important endemic focus of yellow fever. Authorities have been disposed to refer to it as the seed-bed from which the infection has been carried from time to time throughout Mexico and Central America. From some source outbreaks have occurred during the last two years in eastern and western Mexico, Guatemala, Honduras, Nicaragua, and Salvador. Operations covering this entire region are now being carried out under unified administration. In each of these countries Government has created under its national department of health a yellow fever commission. By executive decree these commissions have been given full authority to deal with the situation. The simple device of giving the Board representation on each of the commissions has effected concert of effort. Recent reports indicate a steadily falling mosquito index and a corresponding drop in case reports. In view of the vast extent of the area to be covered effort is being centered on strategic points, and particularly on Merida as the key to the situation.

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Commission to Africa

The objects of the commission to West Africa were two: (1) to determine whether the reported yellow fever in that region is yellow fever; and (2) to ascertain, if the presence of yellow fever should be confirmed, whether control measures were feasible. The commission sailed from London June 30; visited the Belgian Congo, Dahomey, Gold Coast, Northern Nigeria, Senegal, Sierra Leone, and Southern Nigeria; and submitted its report in New York December 2. No authentic case of yellow fever was seen. Conferences and a study of records, however, gave strong indication of the presence of the infection within recent years. The region of suspected infection is vast, travel is difficult, and living conditions are extremely primitive. And to these must be added the deeply rooted native tradition to conceal all cases of sickness. The control of yellow fever, however, even under these trying conditions, is regarded as not altogether impracticable. The commission recommends that the report be accepted merely as a progress report and that another commission be sent out, equipped for a more extensive and prolonged investigation of the situation, including a laboratory study of the suspected fevers of the region.

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Yellow Fever Vaccine and Serum

Killed cultures of *Leptospira icteroides* were first prepared and used by Noguchi for protective inoculation against yellow fever in Guayaquil in 1918, with suggestive results. The vaccine has been used on a considerable scale in Mexico and Central America with results which seem to support the earlier indications. A therapeutic serum prepared by Noguchi is also available for the treatment of yellow fever. The use of this serum given in the early days of the disease in a limited number of cases seemed to reduce the usual yellow fever mortality of 50 to 60 per cent to 9 per cent. These products are being supplied to government authorities in Mexico, the Central American countries, Peru, and Brazil. It is to be borne in mind, nevertheless, that the vaccine, however valuable as a protection to the individual, is *not* a substitute for thoroughgoing mosquito control.

Crusade Against Tuberculosis in France

In 1917 the Board joined forces with Government and the people of France in a national crusade against tuberculosis. For three years the French had borne the brunt of war; the tuberculosis rate was supposed to be high and to be on

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Fig. 4.—History taking in clinic work. Campaign against tuberculosis. France

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Fig. 5.—Traveling unit used by Educational Division, Commission for Prevention of Tuberculosis in France

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the increase; there were in the country but twenty-two tuberculosis dispensaries, and for tubercular cases, military and civilian, not more than 8,000 beds. The situation as viewed by the authorities called for energetic measures.

After conference with French officials and a study of the situation on the ground, operations were organized under a Commission for the Prevention of Tuberculosis in France. The Commission, working at all times in co-operation with the French and with steadily increasing French personnel, undertook to encourage the establishment of tuberculosis dispensaries; to develop centers for the training of visiting nurses; to provide graduate instruction for physicians to prepare them for medical service in connection with the dispensaries; to conduct an energetic educational campaign on a national scale; and to focus all activities in two concrete demonstrations—one comprising a typical congested city arrondissement in Paris, the other the rural de-

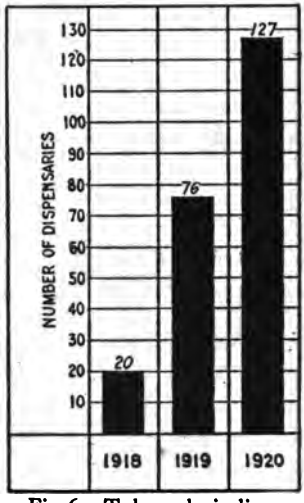


Fig. 6.—Tuberculosis dispensaries functioning in France through initiative of Bureau of Departmental Organization, 1918–1920

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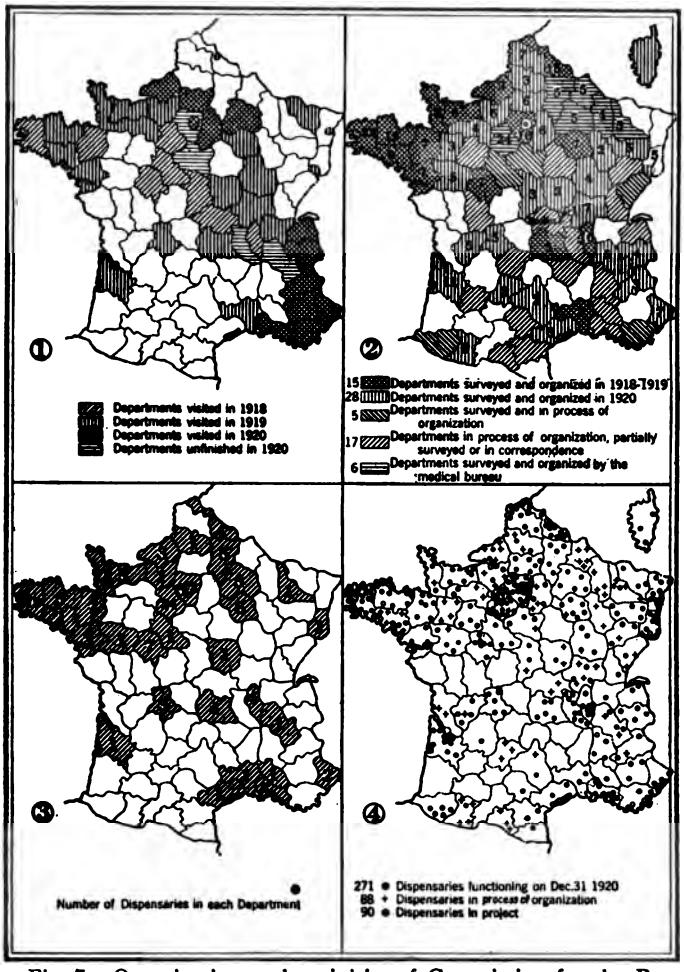


Fig. 7.—Organization and activities of Commission for the Prevention of Tuberculosis in France. 1. Work of educational division, showing departments visited by traveling exhibits during 1918, 1919, and 1920; 2. Work of division of departmental organization, showing departments in which anti-tuberculosis organization has been effected or is in progress; 3. Number of tuberculosis dispensaries in each department co-operationg with the Commission on December 31, 1920; and 4. Total number of tuberculosis dispensaries functioning, in process of organization, or in project at the end of 1920

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partment of Eure-et-Loir. Mobile educational exhibits have covered systematically twenty-eight departments; departmental organization, including dispensaries and provision of hospital beds, has been completed in twenty-one departments; seven centers are in operation for the training of public health visitors, and plans have been matured for the establishment of three—possibly four—permanent training schools; diplomas have been granted to 215 women completing the course. The short courses for physicians have been successful beyond expectations. A sustaining popular sentiment has been created, and Government agencies, national and local, are committed to the task. The National Committee of Defense against Tuberculosis has been organized for the ultimate direction of the work. Present plans provide for completion of the transfer of responsibility to French agencies by the end of 1922.

Team-Play in Malaria Control

A series of field experiments conducted in a group of small towns in southwestern Arkansas during the years 1916-1919 had yielded encouraging results. Similar measures had been applied by the Federal Government in the cantonment zones and a number of small communities in

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many parts of the South. It had been shown that in towns—even small towns of 1,000 to 1,500 inhabitants—under average conditions in the Southern States, malaria can be controlled within limits of cost which such communities may well afford. Conditions seemed to invite a joint undertaking on a larger scale with a view to driving this fact home to the people throughout the more heavily infected region. Early in the year 1920 the United States Public Health Service, the state departments of health, and the Board entered into an arrangement by which demonstrations in malaria control were carried out in fifty-two towns in ten southern states. The local communities provided a liberal share of maintenance costs. Effort was centered on the breeding places of mosquitoes. The measures employed were simple drainage, filling borrow pits and shallow pools, channeling streams, clear-

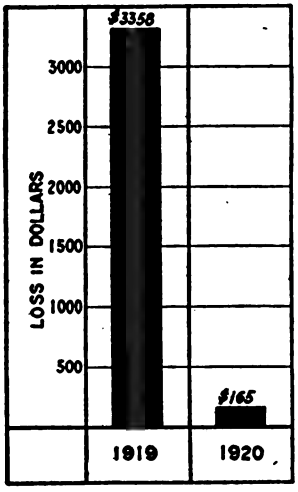


Fig. 8.—Results of malaria work measured in terms of dollars. Comparison of losses due to doctors' bills, medicine, and wages sustained by one Tennessee town during 1919 and 1920, respectively. Eighty-seven families reported cases of malaria in 1919; only sixteen in 1920. Anti-mosquito measures conducted during 1920 cost the town a total of only $1,847.75.

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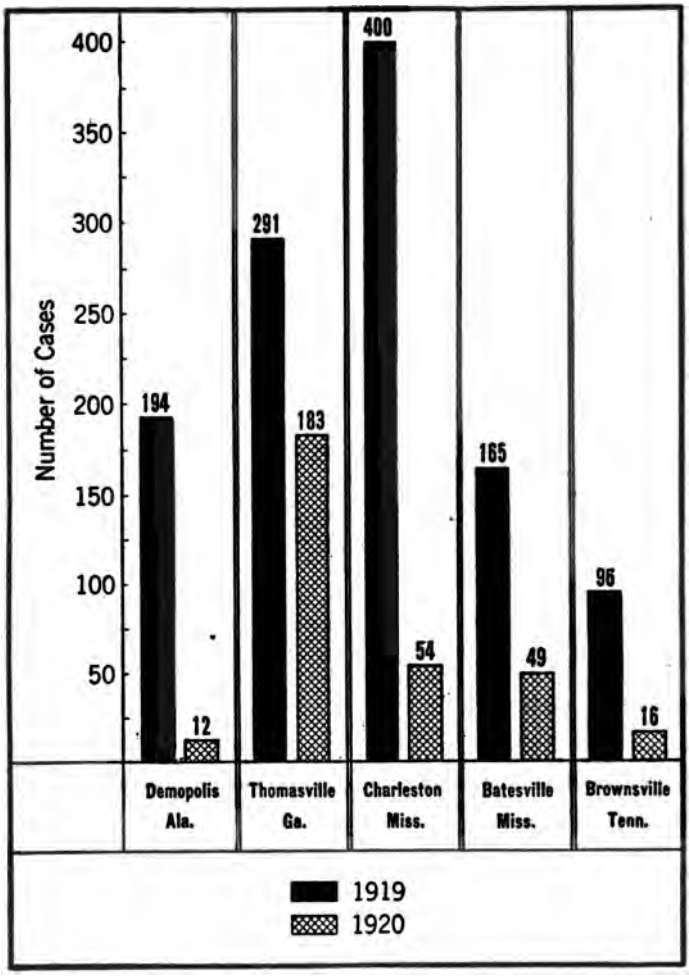
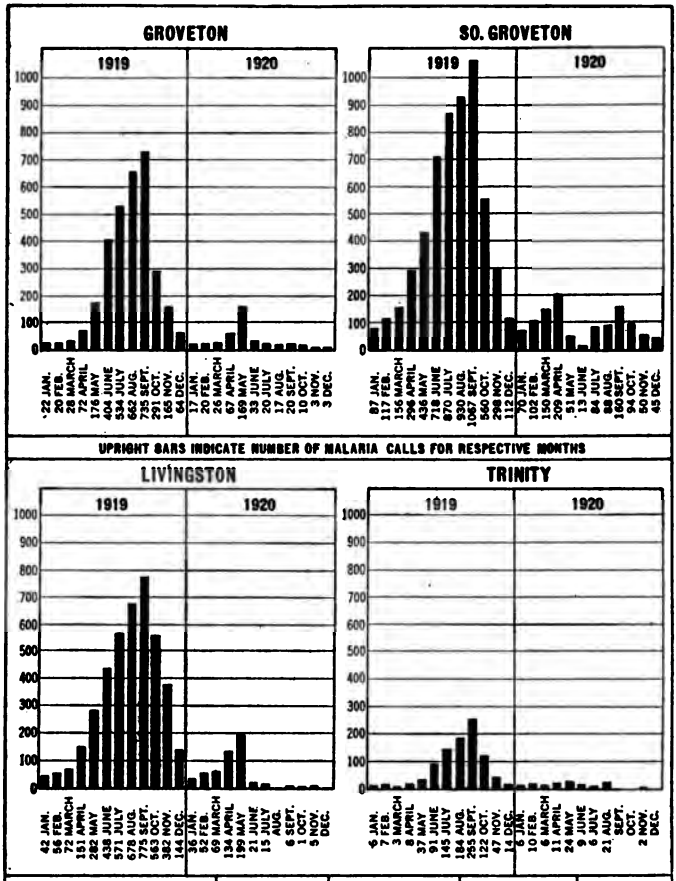


Fig. 9.—Reduction in cases of malaria in five Southern towns where anti-mosquito operations were conducted in 1920 (figures based on physicians' cases). Work was conducted in fifty-two towns, but comparative records of malaria incidence for 1919 and 1920 are not available for all. (See also Fig. 10.)

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		GROVETON	SO. GROVETON	LIVINGSTON	TRINITY
POPULATION		1200	1300	1250	1250
Calls for Malaria	1919	3173	5647	4154	919
	1920	405	1116	538	95
Per Capita Cost	1920	.27	.23	.23	.35

Fig. 10.—Malaria control by anti-mosquito measures in four Texas towns (based on physicians' calls for 1919 and 1920). Control effort began April 1, 1920. (See also Fig. 9.)

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ing the margins of streams and ponds, removing obstructions, turning in the sunlight, oiling, and enlisting the services of the top minnow. Typical results are exhibited in Figs. 9 and 10. The average per capita cost for the fifty-two towns was 78¢ per annum. The records show that such communities having a reasonably heavy infection may free themselves of malaria and of the mosquito as a pest for less than malaria is costing in doctors' bills alone.

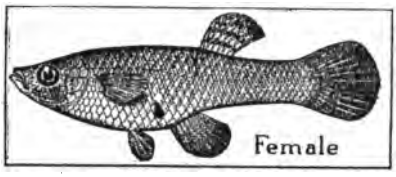
Mosquito Control in a Rural Community

Malaria, however, is a rural disease also. In most infected regions it bears with greatest severity upon the people who cultivate the soil. In 1918 the Board undertook a three-year experiment to test the feasibility of mosquito control in a typical community of scattered farm homes. The area selected was in Hinds county, Mississippi. After one year devoted to a study of the field, a systematic attack was made on the breeding places within one fourth mile of each home. Oil and the top minnow were the principal weapons employed. The results were a further demonstration of the efficiency of the top minnow and a reduction of 77 per cent in malaria incidence at a per capita cost of $2.60 for 1919 and of $3.09 for 1920.

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Fighting Mosquitoes With Fish

The outstanding feature of the experiment in Hinds county was the use of the top minnow (*Gambusia affinis*) as principal agent in the control of Anopheles breeding. The fish were procured from a large pond within the community; they were easily transported, multiplied rapidly, wintered well, and were tremendously effective in devouring mosquito eggs and larvae. Wherever conditions favored their use, they demonstrated important advantages over oil: the original cost represented only the slight labor of transportation; they were relatively permanent, only a few places requiring occasional re-stocking; they were unaffected by rain or wind; and were effective in many breeding places, as in stock ponds and certain running-streams, where oil could not be applied. In 89 per cent of the water deposits within the area in 1919, and in 85 per cent in



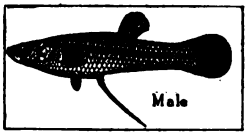


Fig. 11.—Top minnows (*Gambusia affinis*); actual size. These fish reduce the incidence of malaria in control areas by devouring mosquito larvae, which are their favored food

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Fig. 12.—Type of ditch to carry off drain water and prevent mosquito breeding. Malaria control operations, Southern States

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Fig. 13.—Ditching gang at work. Malaria control by anti-mosquito measures, Southern States

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1920, mosquito breeding was kept under complete control by the use of the top minnow alone.

Fish were enlisted in 1920 in the fight against malaria in towns. At Canton, Mississippi, the top minnow effected complete control in 86 per cent of the breeding places; at Athens, Texas, 70 per cent reduction in malaria incidence was achieved through the use of fish alone. Dr. Connor used fish as an important agent in freeing Guayaquil of yellow fever; Le Prince of the United States Public Health Service, demonstrated their effectiveness in Tampico; and they are now being enlisted in the war on yellow fever throughout the infected region in Mexico, Central America, and Peru.

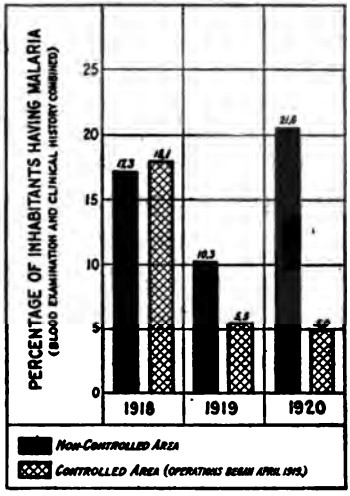


Fig. 14.—Malaria control by anti-mosquito measures, Hinds county, Mississippi, 1919 and 1920. Rate of clinical malaria in controlled area compared with that in non-controlled area. (Note decline of malarial incidence in controlled area despite fluctuation in non-controlled area)

Malaria Control by the Use of Quinine

Theoretically it should be possible to prevent the spread of malaria by an attack on the para-

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site in the blood of the human host. Every mosquito that carries malaria has derived its infection from the blood of an infected person. If the blood of all infected persons in a community were freed of the parasite, malaria should disappear. By field experiment on a large scale Dr. C. C. Bass has shown that in the Mississippi delta, ten grains of quinine a day for eight weeks kills the parasites in the blood of about 90 per cent of the cases treated. Effort has been made to apply the principle in a selected area in Sunflower county. In 1918 the area, comprising 100 square miles and 9,000 inhabitants, was worked intensively by house-to-house visit. All persons shown by blood examination to be infected, and those giving a history of an attack of malaria within twelve months, were given the standard treatment. Quinine was furnished free. During 1919 and 1920 the drug was provided in convenient form at cost. To plantation managers, physicians, and the people living within the area, reduction in malaria incidence has been obvious. It has been difficult, however, to get a definite statistical measurement of results. By the best estimate available the malaria incidence has been lowered from 40 per cent in 1917 to 18 per cent in 1920. The per capita cost has been: for 1918, $1.08; for 1919, $1.09; and for 1920, $0.38.

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The treatment employed by Bass in this field experiment has been endorsed by the United States Public Health Service and the National Malaria Committee, and is being adopted by physicians in their practice. Arrangements have recently been made whereby a commercial agency will supply quinine put up in standard treatment form to stores throughout all malarious communities of the Southern States where the sale of the drug is encouraged by state and local health authorities. This arrangement, by enabling persons desiring quinine treatment to secure it at stores for about half the usual price, will make it unnecessary for health agencies to provide funds for quinine distribution.

Promoting Public Health Through Hookworm Control

Hookworm is one of the most serious of the disabling diseases of man. It is not for this reason, however, that the Board has selected it for so large a share in its scheme of operations. Its control, easily justifiable on its own account, is much more important as a means to a larger end. The disease lends itself readily to purposes of demonstration. It affects fundamentally the welfare of mankind over vast regions, and yet in its cause, its cure, its mode of transmission and means of prevention, it is so

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simple and tangible that the layman—even the illiterate—may be made to see and understand it. Demonstrations in the control of this one disease, while bringing relief to hundreds of thousands of suffering people and increasing the economic efficiency of communities and countries, are having a more important effect in creating a popular interest in public health and in promoting the development of permanent agencies for the control of this and other preventable diseases.

With this object in view, control operations were continued or undertaken during the year in nine southern states and twenty-five foreign states and countries;[1] and infection surveys were carried out in whole or in part in Madras presidency, India; in the islands of Porto Rico, Santo Domingo, and Mauritius; in Colombia; in limited areas of South Australia, Victoria, Tasmania, Northern Territory, New South Wales, and Queensland, Australia; and in the states of Bahia, Pernambuco, Maranhão, Santa Catharina, and Rio Grande do Sul, Brazil.

[1] **Southern States:** Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia; **West Indies:** Jamaica, Porto Rico, St. Lucia, and Trinidad; **Central America:** Costa Rica, Guatemala, Nicaragua, Panama, and Salvador; **South America:** the Federal District and the states of Bahia, Maranhão, Minas Geraes, Parana, Pernambuco, Rio de Janeiro, Rio Grande do Sul, São Paulo, and Santa Catharina in Brazil; and Colombia; **The East:** Ceylon, Papua, Queensland, Seychelles, and Siam.

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Nearing the Goal in the Southern States

Operations in the Southern States for the past ten years illustrate the principle above set forth. In 1910-1911 the Rockefeller Sanitary Commission entered into joint arrangement with eleven states for the relief and control of hookworm disease. Five years later the unfinished labors of the Commission were taken over by the International Health Board and have been continued to the present. The time has now arrived when one may say the object which the Commission had in mind has been accomplished, and the arrangement, so far as this disease is concerned, may be brought to a satisfactory close.

These states have not been freed of hookworm. Far from it. The accomplishment of that result, it was understood and stated in the beginning, is a thing that no outside commission could do if it would and that no such organization should do if it could. This is a work for permanent agencies operating over long periods of time. Nevertheless, the object which the Commission set out to accomplish has been achieved. The disease has been greatly reduced in both severity and prevalence; the people have been enlightened as to its importance, its relief, and the means of its final control; permanent agencies rooted in the soil are committed to the task; and

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a sustaining public sentiment has been created in the interest of more general measures for the better protection of health. Legislative appropriations for public health purposes have increased during the ten years more than 500 per

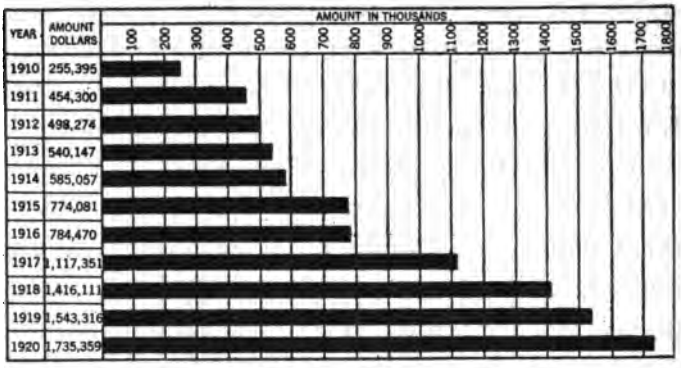


Fig. 15.—Appropriations of legislatures to State Boards of Health in eleven Southern States. 1910–1920. Funds for anti-tuberculosis work included

cent. Full-time county organization is being rapidly developed and measures against hookworm are being absorbed in more general schemes of disease control. In short, the foundation has been laid in these states for a tax-supported health service, state and local, which may be depended upon in the end for the control of hookworm and other preventable diseases.

Comradeship with the states in this service has been an inspiring privilege. Withdrawal from participation in measures directed specifically against this one disease does not terminate or

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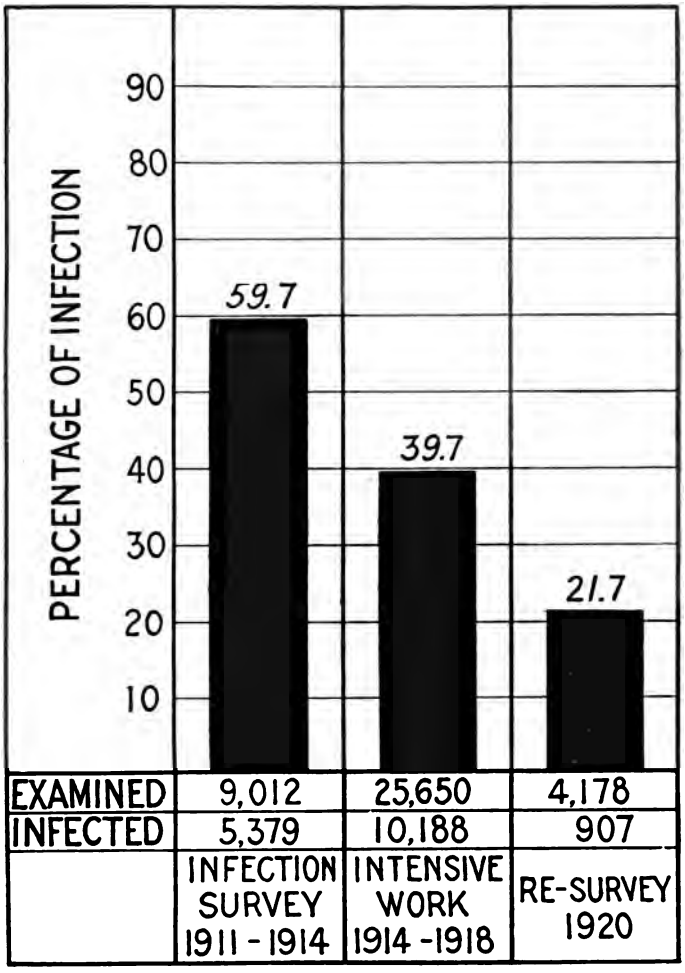


Fig. 16.—Decline in hookworm incidence among school children in Southern States during ten-year period, 1911 to 1920. Based on examination of 38,840 cases in twelve counties

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Fig. 17.—Carrying the gospel of sanitation to native peoples. Attendance at lecture on hookworm disease. Village of Gamilababa, Trobriand Islands, Papua

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disturb this relationship. It makes possible rather the transfer of effort to what have come to be the more strategic points in the general scheme of development. These are for the present malaria control, the county health service, and the training of personnel for the services that are being created.

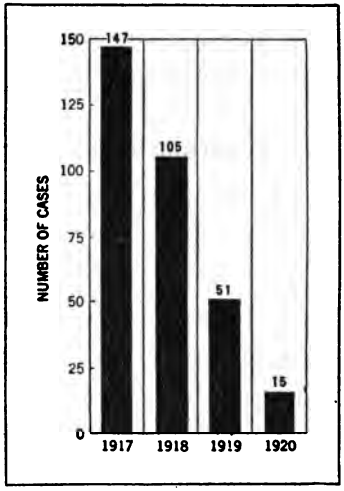


Fig. 18.—Decline in cases of typhoid fever, Monroe county, Mississippi, 1917 to 1920. Measures against typhoid fever constitute an important feature of county health work

Resuming Operations in the West Indies

During the war it became necessary on account of shortage in personnel to discontinue active measures against hookworm in three colonies of this group. Operations are now in progress in Trinidad, St. Lucia, Jamaica, and Porto Rico, with preparations under way for re-opening the work in Dutch Guiana, British Guiana, and Grenada. In all these countries government has undertaken to establish and maintain a system of soil sanitation well in advance of the mobile clinics which follow with an organized scheme of in-

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tensive treatment and education. The outstanding features of recent development have been a slow but steady growth in Government support; conspicuous advance, particularly in Trinidad and Jamaica, in sanitation; and an appreciable movement in the direction of a more general scheme of public health.

Government Assuming the Burden in Brazil

In Brazil official agencies are taking over the burden of hookworm control and are going forward with great energy in the development of a general program of public health. In the autumn of 1916 operations were opened in this country with an infection survey followed by a demonstration in the state of Rio. After this first demonstration, for which the Board provided the funds, the service was rapidly extended on the basis of increasing government support to the Federal District and nine states. Response on the part of officials and the people has been hearty. Within four years the influence of the work has reached the entire populated area of the country. The prevalence and menace of the disease have been demonstrated; the people have been interested and instructed; an awakened public sentiment has multiplied appropriations for public health purposes many fold; Federal and state departments of health with en-

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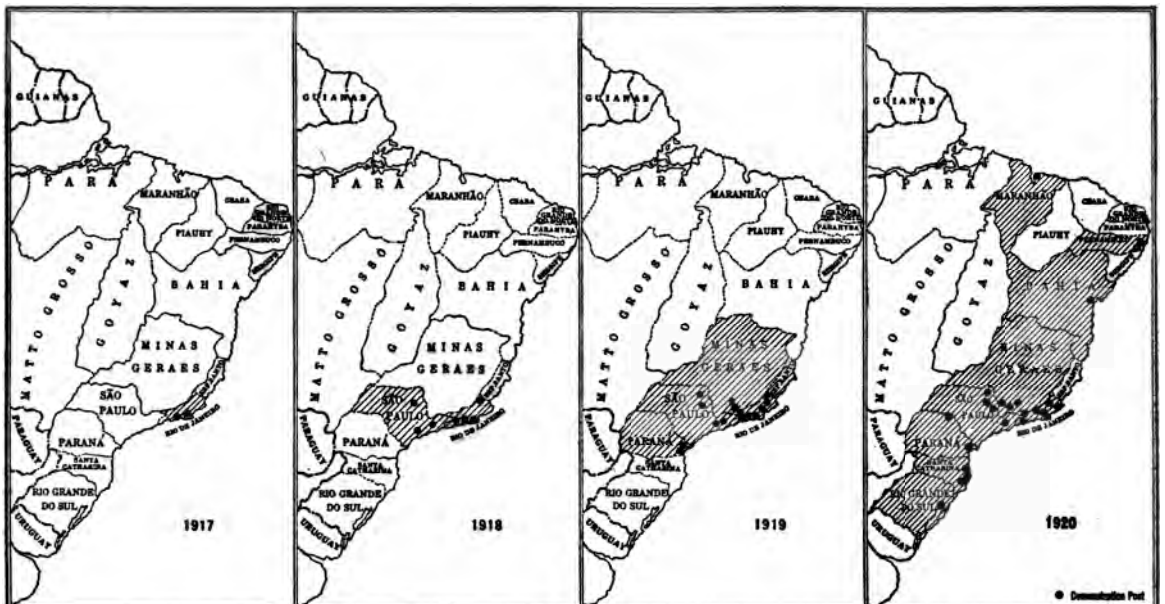


Fig. 19.—Growth of anti-hookworm effort in Brazil. States conducting work and posts maintained, 1917–1920

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larged powers and increased resources have united in a national scheme of rural sanitation in which hookworm disease and malaria are given first place. A heartening example of government team-play! In addition to sharing in the scheme of rural sanitation on an equal basis with the states, the Federal service—recently expanded into a national department of health under the energetic leadership of Dr. Carlos Chagas—is organizing for the Federal District special services for venereal diseases and tuberculosis. A part of the plan is to be a training center for visiting nurses in Rio de Janeiro.

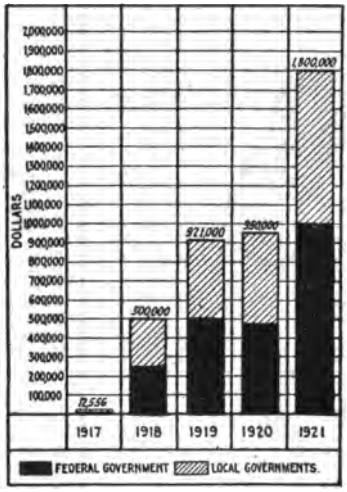


Fig. 20.—Increase in funds appropriated for rural sanitation by Federal and local governments in Brazil, 1917–1921

Here, as in the Southern States, the time has arrived for gradually releasing funds that have been devoted to demonstrations in the control of one disease in order to apply them in ways that may serve the cause to best advantage under present conditions. It is recognized that among the more important immediate needs in the

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further development of effective service in Brazil are: the introduction of the trained visiting nurse; county organization as an integral part of the state system; and at least one institution adequately equipped to provide training for the personnel needed to meet the requirements of this almost unprecedented expansion in public health resources and activities.

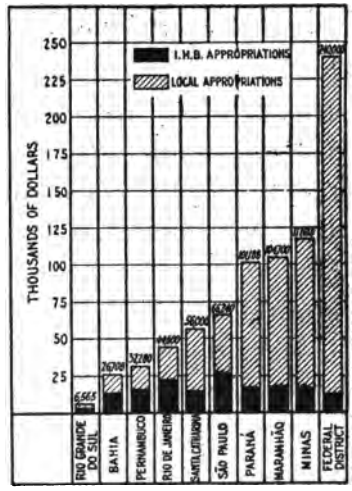


Fig. 21.—Funds available for hookworm work in Brazil, 1920, by states

Progress in Central America

The Central American republics are small and their resources are limited. Measures against hookworm disease were undertaken in these countries in 1914 and 1915 with little expectation of rapid development in general sanitation. Expectations are being exceeded. In **Guatemala** under the new government the public health service has been reorganized and provided with larger resources; by executive decree latrine construction has been made obligatory; and fellowships are being provided for the better training of personnel. In **Salvador** preventive measures

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are in progress in twelve of the fourteen departments; Government has reorganized the national health service; is laying the foundation of a diagnostic laboratory service; and has made available for the year about $97,000 for public health purposes. In **Nicaragua** considerable progress is being made in soil sanitation; Government is establishing a national department of health and is asking the Board's counsel in its organization; and a fellowship has been provided as a first step in the training of men for this service. In **Panama** a permanent sanitary staff is being slowly but steadily developed; and Government has more than doubled its annual appropriation for the work.

In **Costa Rica** the first stage of the work has been completed. The country has been systematically covered; Government has steadily increased its support and has created a national department of health with a special division for the control of hookworm disease. According to present plans entire responsibility for the support and administration of the work is to be transferred to national authorities, and the Board's representative is to be withdrawn by the end of July, 1921. A limited number of fellowships are to be provided for the training of Costa Rican physicians for the new Government service.

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Fig. 22.—Tuberculosis patients cared for by public health clinic. One feature of county health work. Grenada county, Mississippi

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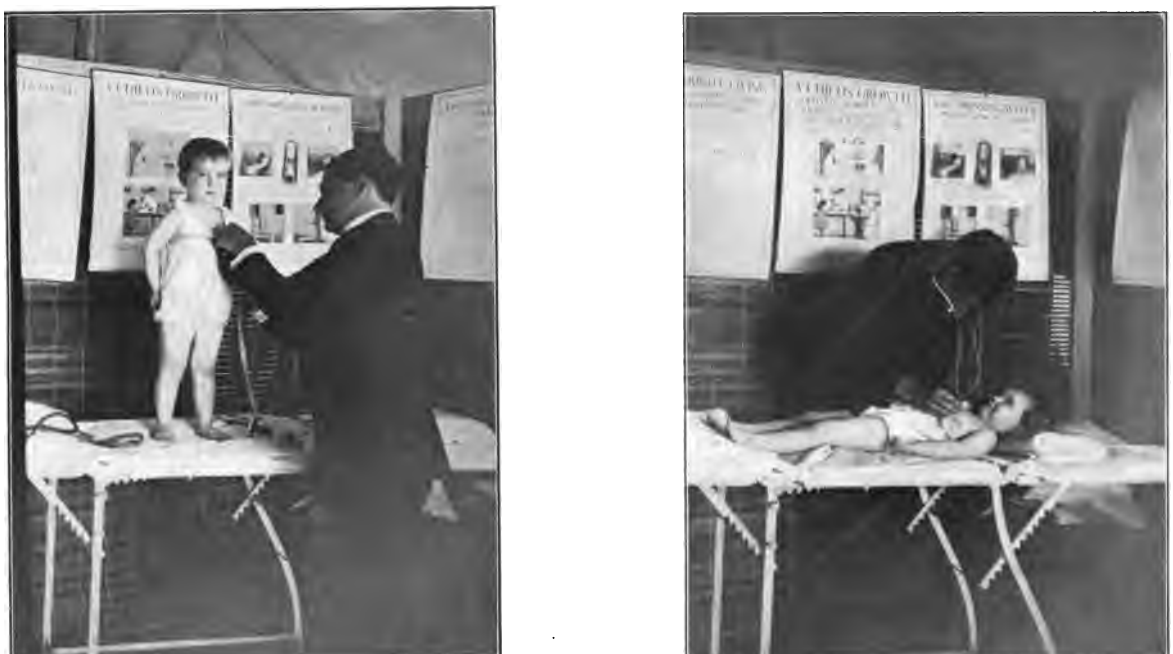


Fig. 23.—Baby clinic, where children from six months to five years were given free medical examination. Another feature of county health work, Grenada county, Mississippi

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First Demonstration in Colombia

The first demonstration in measures against hookworm disease in Colombia was opened with official ceremonies in June, 1920. A survey carried out during the previous year had suggested an average infection of about 75 per cent for the entire population. It is estimated that there are in the country approximately 3,250,000 infected persons, more than 300,000 of whom have been rendered non-productive by this one preventable disease. Officials, planters, and the people are keenly interested and have given active support. Government has pushed soil sanitation far in advance of the mobile clinics and within six months has increased its tax-supported sanitary staff from eleven to eighty-five. One hears talk of a ministry of health. In the meantime the Board is providing fellowships in public health for a limited number of promising young Colombian physicians.

Promoting Sanitation in the Far East

Hookworm control as a means to public health is making progress in the Far East. Notable developments in **Australia** are reported in a separate section. **India**, with its population of more than 300,000,000, suffers the handicap of an extremely heavy infection and for years has served as an endemic focus from which, through

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the emigration of labor, the disease has been carried to many lands. It is among the Tamil coolies imported from South India that the heavier infection is found today in Ceylon, the Federated Malay States, Fiji, Natal, British Guiana, and some of the West Indies. The first systematic attack on the disease at this important source was made by Lieut. Col. Clayton Lane, of the Indian Medical Service, in 1916 on the tea estates of Assam. In response to official request the Board sent a representative during the year to direct operations in Madras presidency, and it has under consideration a similar proposal from Bengal. The island of **Mauritius** has been surveyed preparatory to an active campaign. In **Fiji** Government is undertaking advance soil sanitation in preparation for a revival of the field clinics which were suspended during the war. In **Ceylon** the clinics, having completed for the time being their work on the rubber and tea estates, have been transferred to the low-country villages for a series of demonstrations among the native Singhalese. By joint action of Government and planters, sanitation on the estates is being continued but on most of them has not yet reached a satisfactory standard. In the **Seychelles** Government has undertaken a thoroughgoing demonstration in hookworm control. The islands have been cov-

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ered by a systematic campaign of treatment and education, sanitation is being continued under official inspectors, and as shown by re-survey carried out during the year a marked reduction in the infection rate has been accomplished. In **Siam**, with strong Government backing and energetic Red Cross participation, the field clinics are treating more than 1,000 persons per week. Soil sanitation is making perceptible progress, though under extreme difficulties, and an active educational propaganda is driving home over a wide region the lessons the clinics are teaching. Government has recently expressed a desire to have the work, which hitherto has been confined to northern Siam, made national in scope. This move makes acute the need of a modern medical school in Bangkok for the adequate training of Siamese physicians.

Creating a Ministry of Health in Australia

Australia has shown its usual enterprise in taking advantage of the presence of a relatively light hookworm infection in a limited region for the promotion of a Commonwealth scheme of public health. The movement began in 1917 with an infection survey of Papua. A survey and demonstration in Queensland the following year led to an undertaking on a national scale in which the Federal quarantine service and the

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states united. For two years under this joint arrangement the country has had a demonstration in effective team-play. Officials, physicians, and the people have given support; measures for the control of hookworm disease are being expanded into a more comprehensive plan of rural sanitation; and the new service is being extended to the states, to Papua, and to the territory formerly known as German New Guinea. And now comes report of a step of far-reaching importance. To meet its share of the increasing responsibility the Commonwealth government has created a ministry of health. Under the energetic leadership of Dr. J. H. L. Cumpston, formerly head of the Federal quarantine service, no time is being lost in its organization. In response to request the Board has undertaken to lend to the new ministry during the early stages of its development the services of Dr. Sawyer—its present representative in the country,—of an industrial hygienist, and of a sanitary engineer; to assist in the maturing of plans for a public health laboratory service; and to provide a limited number of fellowships for the training of Australian personnel.

Field Studies

The Board has not entered the field of research as such; it is engaged primarily in promoting

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Fig. 24.—Czechoslovakian commission just before sailing to make a tour of medical centers in England and the United States. Left to right, standing: Dr. Vacek, Dr. Halik, Dr. Bazika, Dr. Hovorka (secretary to Minister of Public Health), Dr. Petrik. Left to right, sitting: Mr. Kolinsky, Col. Russell, Dr. Prochazka (Minister of Public Health), Prof. Gunn. (Col. Russell and Prof. Gunn were not members of the commission)

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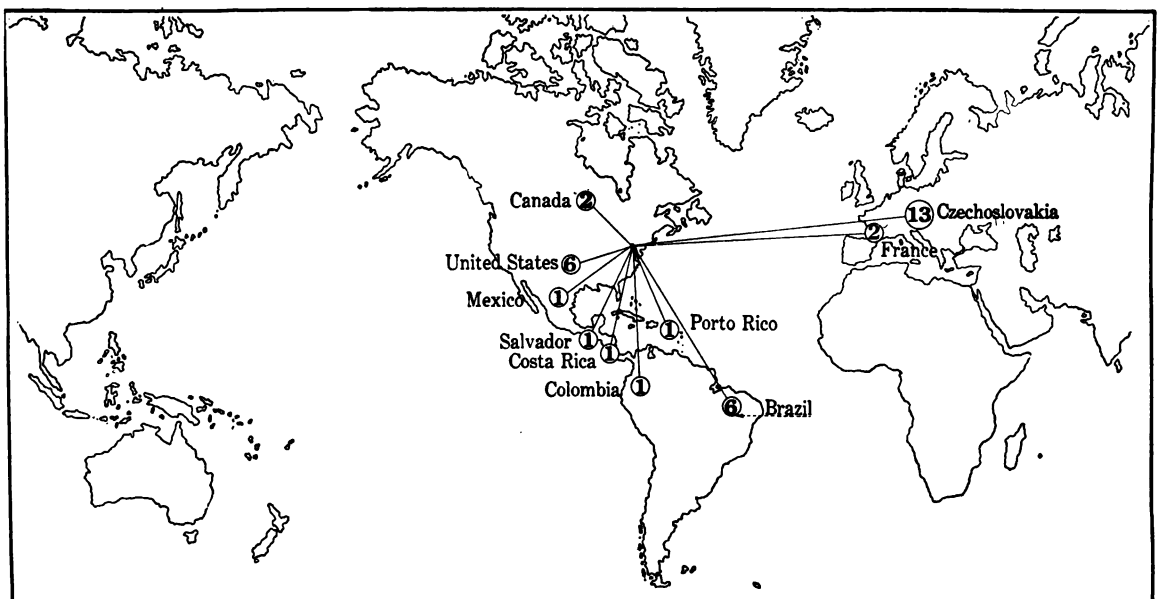


Fig. 25.—The International Health Board has provided thirty-four fellowships for advanced training in public health. The map indicates the countries from which the students have come

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the more effective use of the knowledge which we have in the control of disease. It does aid in developing schools of hygiene which are expected to add to knowledge, and it contributes directly to research when in need of an answer to questions arising from its practical field work. During the year field studies have been conducted concerning hookworm infection; treatment of hookworm disease; technique of stool examination; fish as a factor in mosquito control; and effect on malaria incidence of screening, killing mosquitoes in dwellings, and impounding water in bayous. Members of the field staff have assisted Dr. Noguchi of the Rockefeller Institute in the further testing of his yellow fever vaccine and serum. Results of the studies in the treatment of hookworm disease carried out by Dr. Darling and Dr. Smillie in Brazil are being put to practical test in a number of field clinics in that country, with indications of a very considerable gain in speed and economy of operation.

Public Health Laboratory Service

The laboratory and reliable vital statistics are the necessary basis of intelligent public health administration. In response to repeated requests for counsel the Board has made provision, in the appointment of Colonel F. F. Russell

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of the Army Medical Service to membership on its staff, for giving aid to governments in organizing or further developing their public health laboratory service. He has given such assistance during the year to Alabama, Mississippi, Kansas, and Czechoslovakia.

Creating a Health Service in Czechoslovakia

Under the Empire the administration of public health for the areas now constituting Czechoslovakia was centered in Vienna and Budapest. The present Government is confronted with the task of creating a new service and training a staff to administer it. By invitation two representatives of the Board visited Prague in February for conference with Government authorities and a preliminary study of conditions. Proposals matured at that time and approved by the Board at its meeting in May are now in operation. The Board has a representative at Prague placing American experience at the service of the ministry and interpreting Czech conditions and experience to the home office; as guests of the Board a group of officials representing the ministry have visited England and the United States to study public health administration; thirteen fellowships in public health have been provided for young Czech physicians in training

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for the service being developed at home; and during the autumn the Board's laboratory specialist visited the country and assisted in maturing plans for a national public health laboratory service. The plans provide for a laboratory at Prague, with branch laboratories, as the service requires, at suitable points throughout the country. The scheme will center in an institute of public health with seven divisions: providing for anti-rabic vaccinations; production of small-pox vaccine; production of sera; food inspection; drug inspection; diagnostic laboratory; and courses for the training of public health workers. It is to be under the ministry of health and on the side of instruction is to be intimately related to the University Medical School. Government has appropriated for public health purposes for the year 1921, 81,891,717 crowns.

Institutes of Hygiene and Training in Public Health

The key to permanent progress is in the development of the science of hygiene and the training of men for practical public health administration. There is opportunity at the present time for important work by a limited number of institutions with adequate resources that shall undertake to cover broadly the field

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of hygiene and public health, and to combine with the work of instruction and of practical training the cultivation of the fundamental sciences. In addition to these there will be more abundant facilities in the form of short intensive courses for the continued improvement of the workers in the service. The Johns Hopkins School of Hygiene and Public Health enrolled during the year one hundred students, of whom twenty-nine took the short course. Proposals have been submitted for the development of schools of public health at Prague and at São Paulo, Brazil. The Board contributed toward the maintenance of a health officers' institute or short course in Georgia; and plans are being matured for a similar institute for visiting nurses in the state of New York. The Board provided during the year thirty-four fellowships in public health for selected physicians from ten countries: Mexico, Salvador, Costa Rica, Porto Rico, Colombia, Brazil, France, Czechoslovakia, Canada, and the United States.

Publications

The following is a complete list of the reports and publications issued by the International Health Board during the year 1920:

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PRINTED REPORTS (*for general distribution*)

Annual Report for the Year 1919.

Hookworm and Malaria Research in Malaya, Java, and the Fiji Islands (Report of Uncinariasis Commission to the Orient, 1915–1917). By S. T. Darling, M.D., M. A. Barber, Ph.D., H. P. Hacker, M.D.

LITHOGRAPHED REPORTS (*for limited distribution*)

Annual Reports for 1919 on Work for the Relief and Control of Hookworm Disease in the following countries:

West Indies	
British Guiana	Dr. F. W. Dershimer
Jamaica	Dr. P. B. Gardner
St. Lucia	Dr. Stanley Branch
Trinidad	Dr. G. C. Payne
Central America	
Costa Rica	Dr. Louis Schapiro
Guatemala	Dr. W. T. Burres
Nicaragua	Dr. D. M. Molloy
Panama	Dr. F. A. Miller
Salvador	Dr. C. A. Bailey
South America	
Brazil	Dr. L. W. Hackett
The East	
Ceylon	Dr. W. P. Norris
Queensland	Dr. W. A. Sawyer
Seychelles	Dr. J. F. Kendrick
Siam	Dr. M. E. Barnes

Report on Hookworm Infection Survey and Malaria Survey of Porto Rico from December 26, 1919, to January 28, 1920—Dr. J. B. Grant.

Report on Use of Top Minnow (*Gambusia affinis*) as an Agent in Mosquito Control—Dr. H. H. Howard.

Articles and Reprints

The following is a list of other contributions to medical and public health literature which were made during the year, most of them in the form of

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articles published in medical journals that are widely circulated among persons interested in medical and public health topics:

Dr. C. C. Bass

Attempt to explain the greater pathogenicity of Plasmodium falciparum as compared with other species. *Journal of Tropical Medicine and Hygiene*, Oct. 1, 1920, v. 23, p. 237–238.

Campaign against malaria: malaria, how to get rid of it. Mississippi State Board of Health. *Health Bulletin*, Oct.–Dec., 1920, v. 8, p. 1–2. Same reprinted.

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APPENDIX

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ACKNOWLEDGMENT

Extensive use has been made of the following special articles and reports in compiling the appendix, particularly the sections dealing with hookworm disease and county health work:

"Studies on Hookworm Infection in Brazil," by S. T. Darling and W. G. Smillie; published as monographs of the Rockefeller Institute for Medical Research, New York City, 1921.

"Studies in Relation to the Technique of Field Campaigns," by W. G. Smillie.

"Co-operative County Health Work in North Carolina," by B. E. Washburn; published as health bulletin of North Carolina State Board of Health, Raleigh, N. C., January, 1920.

In certain instances the authors' own words have been used. The Board is indebted to these as well as to many other members of the staff for contributions in the form of reports and articles which have made possible the following statement of findings and results.

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APPENDIX

I

EXTENT AND SEVERITY OF HOOKWORM DISEASE[1]

During 1920 hookworm infection surveys were conducted in sixteen areas.[2] In these areas the incidence as indicated by microscopic examination of feces ranged from the complete absence of infection recorded in four Australian states to the almost universal infection recorded in the states of Bahia, Pernambuco, and Maranhão, Brazil. In areas where the rate of infection was high the disease was found to be prevalent even among those who had the means to cure and who protect themselves against it. Thus, in the state of Santa Catharina, in Brazil, 78 per cent infection was recorded among those who could read, 57 per cent among those who claimed to use latrines, and 46 per cent among a group of teachers, doctors, druggists, lawyers, and fazenda or plantation owners.

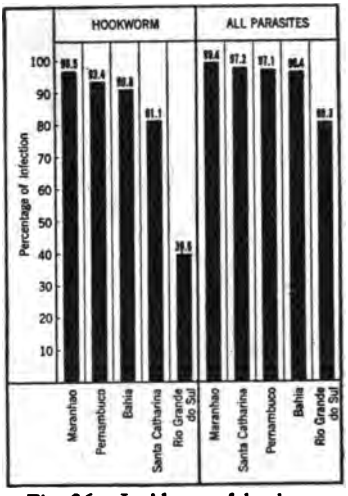


Fig. 26.—Incidence of hookworm and other parasitic infection in five Brazilian states surveyed during 1920

Distribution of Hookworm Disease in Brazil. Surveys have now been made of all the larger states of the Brazilian littoral except Pará. The general results are indicated on the map, Fig. 27. The southern boundary of Bahia may be taken as the dividing line between an area of severe infection to the north and an area to the south where the infection, although probably still high in rural regions, is on the

[1] Based on 1920 infection surveys.

[2] The states of Bahia, Pernambuco, Maranhão, Rio Grande do Sul, and Santa Catharina in Brazil; the republic of Colombia; the islands of Porto Rico, Santo Domingo, and Mauritius; the presidency of Madras, India; and the states of Queensland, South Australia, Victoria, Northern Territory, New South Wales, and Tasmania in Australia.

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average less intense. This area of less intense infection extends to the southern boundary of São Paulo. Along the coast the incidence remains about 80 per cent to the extreme southern limit of Brazil, although in the southernmost state—Rio Grande do Sul—this condition is confined to a very narrow strip indeed. A little further inland the incidence drops to 70 per cent, and beyond falls away rather abruptly to nothing.

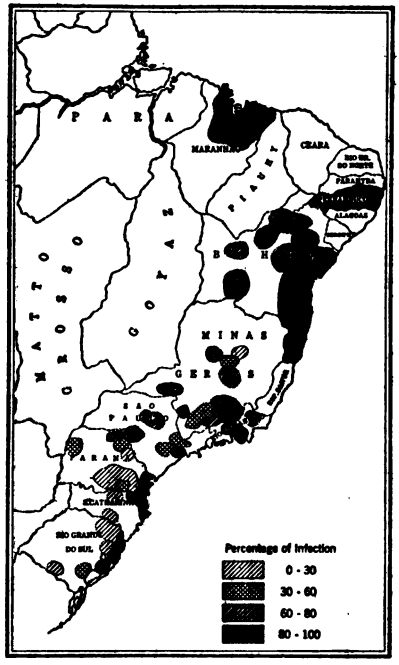


Fig. 27.—Distribution of hookworm infection in Brazil, as indicated by infection surveys. Note extreme high incidence along the coast

Infection along the littoral seems to be invariably more severe than further inland. This condition is probably due in the different regions to different combinations of causes, into which enter climate, concentration of population, and prevailing occupations of the rural inhabitants. In northern São Paulo and southern Minas the high incidence of infection seems to be due mainly to intensive agriculture; in Rio and Santa Catharina to particularly favorable conditions of soil, temperature, and moisture. In the three northern states surveyed the difference is slight but still apparent (Fig. 27).

There remain along the coast six states of relatively small areas which have not yet been surveyed. The indications are that two of these—Piauhy and Ceará, which lie between Maranhão and Bahia—will not show the same high incidence of infection as the latter states. Piauhy and Ceará suffer periodically from long-continued droughts—sometimes a year passes without rain; and this situation in itself would tend to control hookworm infection. Alagoas and Sergipe will probably show the same infection as the bordering states of Pernambuco and Bahia; Parahyba and Rio Grande do Norte may be expected to show a transition from the universal infection of Pernambuco to the less serious situation supposed to exist in Ceará.

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In the great interior states of Brazil the population is so sparse that hookworm disease becomes one of the less important problems.

Infection Rate in Colombia. In the infection survey of Colombia, investigation was limited to the department of Cundinamarca. This department includes within its boundaries all the climatic zones into which the country is divided and is believed to be fairly representative of the country at large.

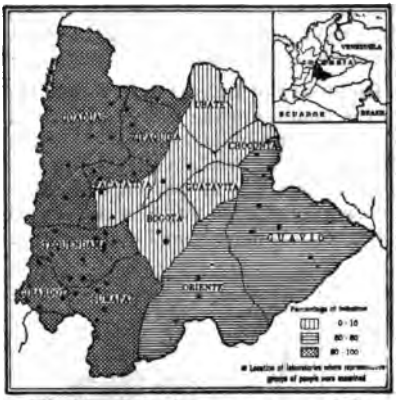


Fig. 28.—Infection survey map of Cundinamarca, Colombia. (Insert shows location of the department in the republic)

Examination of 8,465 representative persons from forty-five different districts and all of the zones showed 6,613, or 78.1 per cent, to be harboring hookworms. The incidence was found to vary inversely with the altitude, decreasing rapidly as the cold zone was approached. The highest rate of infection (88.1 per cent) was found in the provinces of Guaduas and Tequendama; the lowest (9.6 per cent) in Bogotá and Guatavita (Fig. 28).

The survey findings in Cundinamarca showed that the people who lived in districts having an altitude of less than 6,600 feet had an average infection rate of 84.4 per cent. Among those who lived in higher altitudes the average percentage of infection was 20.4 (Fig. 29). By applying these figures to the country as a whole, it was calculated that in a population of 5,072,613 there were as many as 3,320,602 infected persons. Since 10 per cent is a reasonable estimate of the number of hookworm cases

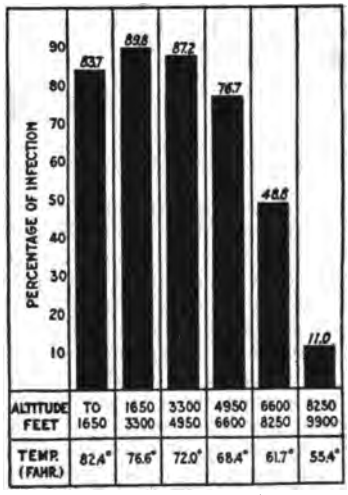


Fig. 29.—Hookworm infection in relation to altitude. Colombia. In zones of less than 6,600 feet elevation, infection was practically universal

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that are unable to work, the survey may be taken as indicating that the nation is supporting more than 300,000 persons who have been rendered non-productive by a single preventable disease.

Incidence of Infection in Santo Domingo. An estimate based on the findings of the survey of Santo Domingo places the approximate incidence of infection for the country at about 50 per cent. In the Cibao, the fertile valley lying north of the central mountain range, where live 57 per cent of the total population, the rate of hookworm infection was 67.4 per cent (Fig. 30). This region is not only the most densely and uniformly settled part of the country, but

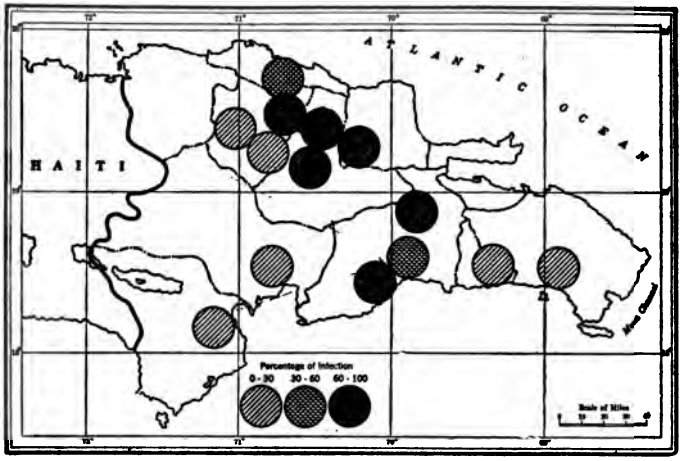


Fig. 30.—Distribution of hookworm disease in Santo Domingo

it presents, with its soil of rich loam and its constantly recurring rainfall, conditions almost ideal for the propagation of hookworm larvae. In the plains south of the mountain range, where dwell an additional 28 per cent of the population—living chiefly along the seacoast—the infection revealed was 43 per cent. Here was found the greatest variation in the incidence of infection; it was heaviest in the vicinity of the capital and lowest in the more sparsely settled sections lying along the southeastern coast. The arid western area, comprising the provinces of Monte Christin Azua and Barahona, with a very sparse population which approximates only 15 per cent of the total for the country, revealed a hookworm incidence of 11.4 per cent.

The clinical results of the infection are not severe, probably because the population is largely of negro blood and the infection is in the main of recent origin. Tests made during the course of the survey showed that the hemoglobin of persons with hookworm disease was not greatly reduced. In 283 infected persons the average hemoglo-

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bin was found to be 74.4 per cent, as compared with an average hemoglobin of 79.3 per cent in 221 uninfected persons. Nevertheless, in spite of the fact that the disease has thus far caused little clinical anemia, there is much to indicate that its presence is a serious hygienic and economic problem and likely to become an ever more pressing one as time goes on. The need of controlling it, therefore, stands among the more important specific sanitary problems to be met by the island government.

Hookworm Infection in Mauritius. In Mauritius not less than two of every three among the 2,867 persons examined were found to be harboring the hookworm parasite. The persons examined included all ages, all races, and both sexes, and were chosen indiscriminately over wide areas. The infection rate ranged from 29.4 per cent among residents of the Port Louis district to 100 per cent among those of Moka (Fig. 31). From the survey records it may be conservatively estimated that 226,000 persons in the colony are infected.

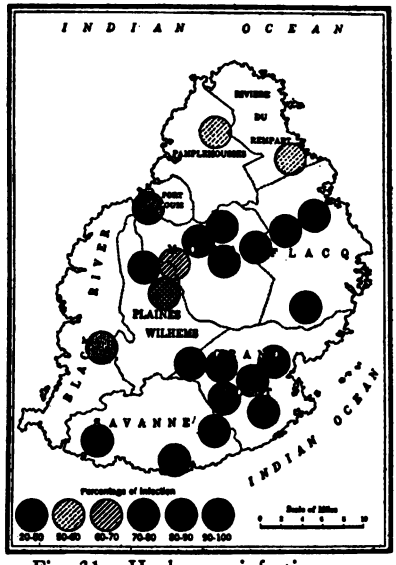


Fig. 31.—Hookworm infection survey map of Mauritius

The effects of the disease fall most heavily on the East Indian estate laborers, many of whom are extremely weak, anemic, and edematous, and suffer from disturbances of the heart. Persons presenting these symptoms were seen in all parts of the island, but more frequently in the districts with the higher percentages of infection. Districts with much rainfall had consistently higher and more severe types of infection than those with little rainfall, the incidence of infection in wet and dry districts being, respectively, 74.6 and 44.7 per cent (Fig. 34).

Hookworm Survey of Madras Presidency, India. Demonstrations or surveys were conducted during 1920 in the Cannanore jail in Madras presidency, India, on various tea estates, and later in the city of Madras. On the tea estates a total of 2,300 laborers were examined, and the infection rates were found to vary from 83 per

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cent among laborers from dry districts to 100 per cent among those from wet districts. Among 964 inmates of the Cannanore jail, a hookworm incidence of 89.7 per cent was found. Prisoners drawn from all but three of the twenty-four districts of the Presidency were included in the number examined. There were very few instances of severe or even moderately severe hookworm disease among the prisoners; among the estate laborers, on the other hand, the proportion of severe cases, as determined by clinical observations as well as by hemoglobin tests, was very large.

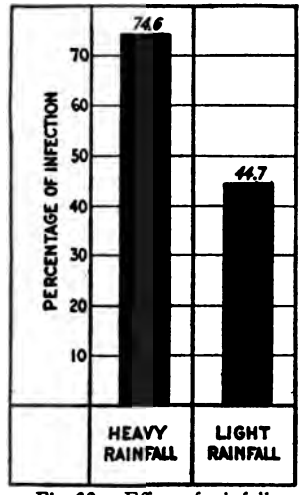


Fig. 32.—Effect of rainfall on hookworm propagation. Comparative incidence of the disease in districts with heavy and with light rainfall. Mauritius

The city of Madras was chosen for investigative work in an industrial center. Among urban residents employed in the cotton and silk mills of the city, two of every three persons examined were found to be infected. The rate of 55.7 per cent found among school children, who almost without exception go barefoot, was in sharp contrast with the rate of 15.8 per cent which obtained among teachers, almost all of whom wear shoes.

Hookworm Infection Not Widespread in Australia. The results of the work in Australia up to December 31, 1920, lead to the conclusion that hookworm infection is confined principally to irregular pockets and is not very widespread. The principal factor determining the shape and position of the pockets seems to be rainfall. This has greater influence upon the extent and severity of infection than have variations in methods of night soil disposal: in some communities of low rainfall hookworm disease has gained no foothold in spite of the grossest carelessness in the disposal of feces.

Relationship between Rainfall and Infection. Surveys conducted during the year in South Australia and Victoria, where rainfall is low and occurs mostly in winter, indicate that hookworm disease is absent from the mines as well as from the surface. Similarly, a survey of the important group of deep mines at Broken Hill, in New South Wales, and another survey begun on a small scale in and around the city of Darwin, in Northern Territory, have disclosed no hookworm infection.

In Papua the infection rate is high, 58.8 per cent of the 18,088 persons examined to date having been found infected. Even in this

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Fig. 33.—Worms recovered from nine-year-old boy as result of one treatment with oil of chenopodium. Eighty-nine hookworms and eighty-one Ascaris. This demonstration induced many to apply for treatment. Brazil

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Fig. 34.—Laborers at estate camp in island of Mauritius. One hundred per cent hookworm infection

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tropical country, however, there is an area along the southern coast in which rainfall is low and the incidence of hookworm disease is much reduced. Of the areas examined on the continent of Australia, only the state of Queensland has thus far shown a serious hookworm problem; even here, however, the infection is confined to a narrow strip of coastal area. Inland from the coastal ranges the rainfall is low and hookworm disease is rare or absent (Fig. 35.)

Racial Incidence of Infection. Infection by race presents a curious anomaly in Australia. In the few places where the aborigines still live together, they have a much higher infection rate than the white people of the same district. It is only occasionally that a community is found where more than 30 per cent of the whites are infected. Aborigines living under the same conditions are all likely to be infected. In Papua, also, the high infection is almost entirely limited to natives. There are, however, only a few whites living in the latter territory.

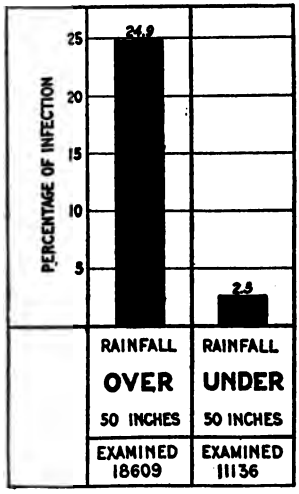


Fig. 35.—Relation of rainfall to hookworm incidence. North Queensland, Australia

SEVERITY OF HOOKWORM DISEASE

Usually, the higher the percentage of persons infected in a given locality, the larger is the average number of worms harbored by infected persons, the more severe are the symptoms, and the more difficult is it to bring the disease under control. Rates in the preceding paragraphs relating to the incidence (but not the severity) of the infection are based entirely on the results of search with the microscope for eggs in the feces. The work of Darling and Smillie has shown, however, that the microscope offers no trustworthy index of the *number* of worms harbored by infected individuals. This information may be accurately ascertained only by giving the persons a vermifuge and counting the worms expelled after the drug has acted. Studies which seek to establish through microscopic examination the relationship of race, sex, age, occupation, and similar factors to the *incidence* of hookworm infection lose a large part of their value when considered in the light of information revealed by the worm-count method.

Value of Worm-Count Surveys. The fact that the microscope cannot be expected to reveal differences in the amount of the infec-

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tion was demonstrated, for instance, in the state of São Paulo, where worm counts showed that male coffee pickers had 350 worms on the average while their wives had only fifty; yet the microscope could do no more than call positive both the husbands and the wives.

Worm counts are scarcely practicable when the incidence or severity of the disease is to be studied over a wide area and within a limited period of time. Nevertheless, it is sometimes feasible to make them as an incidental feature of the work within restricted areas, and this was done in the course of the infection surveys conducted during 1920 in the states of Pernambuco and Santa Catharina, Brazil. In Pernambuco from 500 to 800 worms were repeatedly recovered from the feces passed by agricultural laborers during the first few hours after treatment, and in Santa Catharina the worms obtained after treatment with thirty-five to forty drops of chenopodium ranged from 1 to 1,156. One child of five years expelled 412 hookworms. In the latter state, moreover, children from nine to twelve frequently expelled from 100 to 150 Ascaris (Fig. 32).

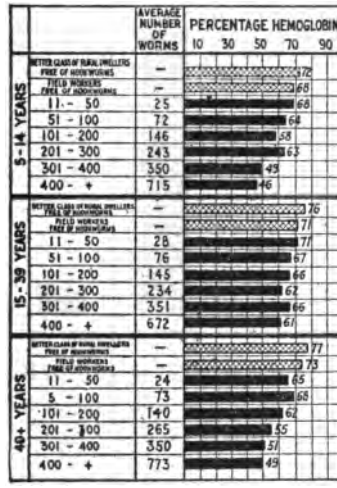


Fig. 36.—Children and old people in rural Brazil suffer more severely than young adults from the effects of hookworm disease. Hemoglobin index in relation to number of hookworms harbored. Distribution by age groups

Correlation between Number of Hookworms and Hemoglobin Index. The hemoglobin index is a very good means for determining, in the case of individuals as well as of groups, the degree of injury that hookworms are producing. Fig. 36 illustrates the relationship between the hemoglobin index and the number of hookworms as ascertained by Drs. Darling and Smillie in their work in rural Brazil. Seventy-five worms are seen to produce in all groups a definite lowering of the hemoglobin amounting to about four points. As the worms increase in number beyond this figure, the hemoglobin of children and of persons more than forty years of age declines rapidly and continuously until the index of cases with upward of 400 hookworms is more than twenty points below normal.

Persons between fifteen and thirty-nine offer such strong resistance to the disease that even 675 to 700 hookworms cause a decline

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in hemoglobin of only ten points. In interpreting these facts, it should be borne in mind, however, that hookworm infection is slowly acquired, that the blood-forming elements of the bone marrow are active, and that the body defenses struggle against the hookworms to retain the normal hemoglobin. In older individuals and in children the body defenses have little endurance, and if hookworm infection is heavy, the battle is a losing one.

Hookworm the Chief Anemia-Producing Factor in Santa Catharina. In a study of 9,482 persons in Santa Catharina hookworm disease was easily incriminated as the chief cause of anemia. As a single factor in the production of anemia it appeared on the average more potent than malaria, although it produced its severest anemia only when in conjunction with malaria. Regionally and occupationally the infection was correlated with the intensity of anemia. It was evident that of all the groups examined the inhabitants of the coastal plain (90 to 95 per cent infected) suffered most severely from anemia, and chief among them the field workers (94 to 98 per cent infected), who represent one fourth of the population and are the chief producers of wealth. Second in both extent and gravity of anemia were those less than nineteen years of age (90 to 93 per cent infected), and third the housewives (80 to 85 per cent infected).

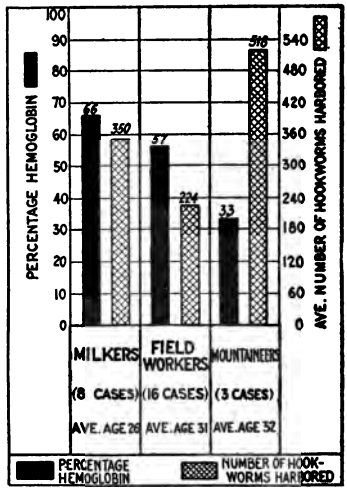


Fig. 37.—Malnutrition and hookworm disease as factors in producing anemia. Comparative study of well nourished and poorly nourished occupational groups. Milkers well fed; field workers moderately well fed; mountaineers poorly nourished. Brazil

Hookworm Disease and Malnutrition in Relation to Anemia. In the state of São Paulo, Brazil, however, studies of hookworm disease and the food factor in their relation to the production of anemia suggested that malnutrition, especially when it approaches the point of starvation, is more potent even than heavy hookworm infection in reducing the hemoglobin. One of the São Paulo studies was based on worm counts and hemoglobin tests of eight milkers who engaged in field work part of the time, of sixteen laborers who gave all their time to work in the fields, and of three mountaineers. All of these men were heavily infected. The milkers drank

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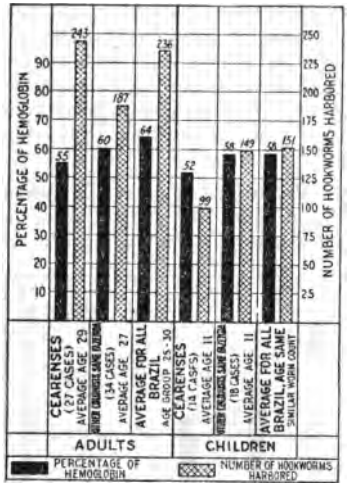


Fig. 38.—Malnutrition and hookworm disease as factors in production of anemia. Resistance to anemia among hookworm infected refugees from famine-stricken district of Ceará compared with that among hookworm infected colonists who had been living on Sao Paulo plantation for several years

plenty of milk and had other good food; the field workers had good food but no milk; the mountaineers were poor and underfed. Fig. 37 compares the hemoglobin average of the three groups. The milkers were relatively strong and active; the mountaineers were weak and listless.

In another study, forty-one refugees who had migrated to São Paulo from the famine-stricken state of Ceará were compared with fifty-two laborers who were native to the state of São Paulo. Both groups at the time they were studied were eating similar food, living under similar conditions, and performing similar tasks in the fields. Both were infected with hookworms. The São Paulo laborers, who were accustomed to a comparatively full diet, had, as Fig. 38 indicates, a much higher hemoglobin index than the refugees from Ceará, who had suffered from malnutrition. The difference was especially noticeable in the case of children. Those from Ceará harbored only 99 worms, as compared with the average of 149 harbored by those who were native to São Paulo, yet the hemoglobin index of the former group was six points lower than that of the latter.

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11

FIELD STUDIES OF HOOKWORM DISEASE

Drs. Darling and Smillie have conducted in Brazil a number of investigations in which they have sought to throw light upon the varying incidence and severity of hookworm disease in different groups of the population, and the factors which determine this variation. Their studies have been based on the careful counting of worms expelled by infected persons.[1] They have carried out their experiments in their capacities of Director and Associate Director of the Laboratory of Hygiene at the university of São Paulo, Brazil, and have been assisted in the work by the staff engaged in combating hookworm disease in Brazil.

Direct Contact with Humid Earth Chief Factor in Infection. The studies bearing on the relationship between contact with humid earth and the incidence of infection with hookworm disease demonstrated that under Brazilian conditions hookworm is an occupational disease—a disease of those who work in the soil. The number of worms harbored was found to vary directly with the amount of time the individual spent in bare feet in the fields.

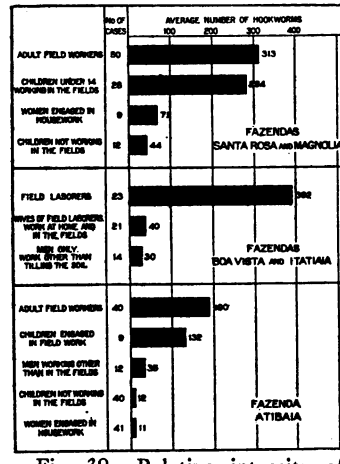


Fig. 39.—Relative intensity of hookworm infection among agricultural laborers and persons engaged in other occupations. 299 cases. Brazil

Fig. 39 shows that on fazendas in several different states, adults and children who worked barefoot in the field were heavily infected, while those who were engaged about the house harbored but few worms. Almost without exception the more intimate and direct was the contact of these people with the humid earth in which the larvae breed, the more severe was the infection they exhibited.

Contrary to expectation, the average infection of people grouped in villages with little or no sanitation—shopkeepers, barbers, and non-agricultural workers generally—proved to be not so heavy as that of persons living in scattered farmhouses. Even though the

[1] For full discussion of the methods employed, see pages 72 and 73.

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soil in and about the villages teems with hookworm larvae, the people themselves are not in actual contact with the soil. Many inhabitants of rural communities, too—persons such as school teachers and plantation owners, who generally live amid good surroundings—showed little infection because their skin did not come in contact with infected soil. Residents of cities with paved streets and latrines were found to be lightly infected unless in recent years they had been workers in the fields.

Slow Acquisition of Hookworm Infection. Theoretically it is possible to acquire massive infection with hookworms following a single exposure; the field studies in Brazil showed that actually this does not occur. They indicated, on the contrary, that the infection is gradually acquired, a worm here and another there, and that many days and weeks pass without any addition to the number harbored. This fact is well illustrated in Fig. 40, which shows by age groups the increase in the number of hookworms harbored by children. Those who begin work in the fields at eight years have an average infection of about fifteen worms each. Until the fourteenth year this infection increases at the rate of about fifty worms a year, or approximately one a week. Children who do not work in the fields gain only one worm every six weeks, or eight a year.

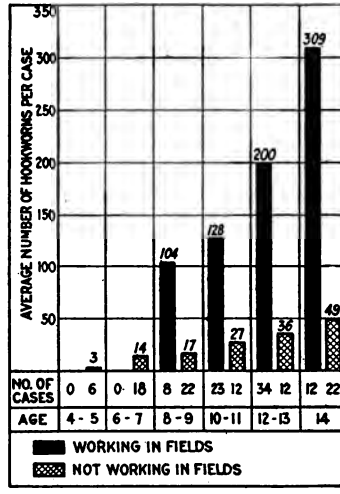


Fig. 40.—Relative intensity of hookworm infection among children working in the fields and those not working in the fields. Classification by two-year age groups. Brazil

At ten years of age, less than half of the children have ten worms each. This means that they have picked up on the average not quite one worm a year. Not a single child of all those examined who were ten years of age or less harbored 150 hookworms. Nevertheless, many of them had been working continuously in the fields and for more than two years had been constantly exposed to the heavily infected soil.

The slow acquisition of the infection was further demonstrated in a group of Japanese colonists engaged in field work in Brazil. Some of them had been working in highly infected soil for about two years, but had only begun to lose the Ancylostomes which they had brought with them from Japan and to acquire the Necators which are common to Brazil. Other Japanese on the same fazenda who had been in

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Brazil for more than four years had acquired a large number of Necators, though even by the end of this period they had not acquired so many of the latter species as the average number harbored by native Brazilians who worked side by side with them (Fig. 41). In another instance a woman eighteen years of age who had been a servant in a city home all her life until her marriage to a colonist, when she began to spend some time at work in the field, had not acquired a single hookworm after four months' service, despite the fact that the soil in which she worked was heavily infected.

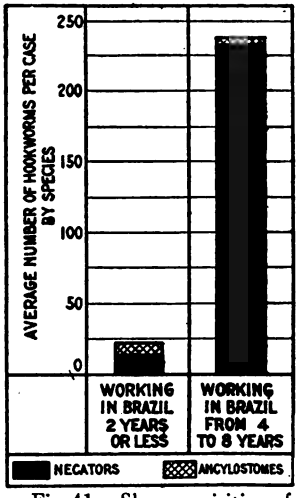


Fig. 41.—Slow acquisition of hookworm infection. It takes Japanese field laborers in Brazil from four to eight years to acquire any considerable number of Necators, the species of hookworm common to the New World

Slow Loss of Hookworm Infection. The infection that is gained so slowly is also slowly lost. This was demonstrated by the following instances. A study of a group of people in a village in the state of Rio gave an average of twenty-eight worms among those who did no field work. Two members of this group, a brother and a sister eighteen and twenty-one years of age, respectively, had worked in the fields from childhood until three years previously, when their father moved to the village, became more prosperous, and provided his children with shoes. The brother and the sister then gave up field work and lived under comparatively good hygienic conditions, but when examined still harbored 318 and 233 worms, respectively. The average infection of field workers in the original district was 390 worms.

In the same village a servant girl of twenty-three years who had left the fields four years previously to work in the kitchen of a wealthy landowner, where she was surrounded by the best sanitary conditions, when examined still harbored 369 worms. Another young woman who, after having worked for years in the fields, had been married three years previously and had since devoted herself to housework, yielded when treated a total of 379 worms.

Effect of Shoes on Infection. Any factor that limits or prevents the contact of bare feet with humid earth should lower the degree of infection. Drs. Darling and Smillie gave attention to the use of shoes as a factor of this kind. In rural Brazil it is almost the universal custom to go barefoot, partly because of the inconvenience which results from wearing shoes and partly because

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shoes are so expensive. When working in the field, children never wear them, and adults only rarely.

Groups of adult laborers were studied in three widely scattered localities having conditions practically identical with respect to food, shelter, and type of work. From adult shoe-wearers an average of 27 worms per case was obtained; from barefoot field laborers working side by side with the shoe-wearers, an average of 255 worms per case (Fig. 42). In the family of a Spanish colonist there were six adults who wore in the field a simple, crude, home-made shoe, and four children who went barefoot. From the adults the average number of hookworms obtained was 40; from the children, who should normally have harbored far fewer worms than the adults, 226.

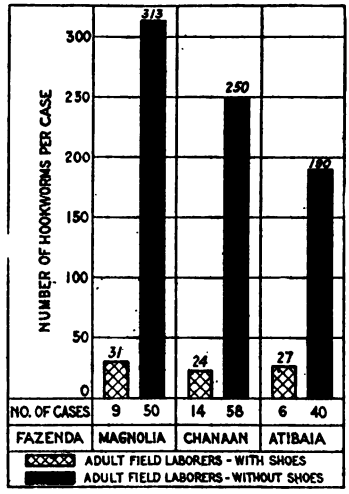


Fig. 42.—Effect of shoes in controlling hookworm infection. Worms harbored by field workers wearing shoes compared with number harbored by those not wearing them. Three coffee plantations in Brazil

Hookworm a Disease of Young Adults. So far as representative Brazilian areas are concerned, the investigations of Darling and Smillie have shown that hookworm disease is a disease of youths and young adults, particularly males. It makes its most severe attack on persons between fifteen and forty-five years of age—in the productive period of life. Fig. 43 shows that the number of worms harbored by males rapidly increases up to the fifteenth year; there is then a gradual, slow, and steady increase throughout the active period of life, with finally a break between the ages of forty-five and fifty and a strikingly abrupt diminution after the latter age.

When the field laborer between twenty and forty-five becomes infected with many more than 200 to 300 hookworms—the average for his age period—he becomes unable to spend so many hours in the field as do his less heavily infected fellow-workmen. His enforced absence from the field for a part of the working day lessens his opportunities for acquiring new infection. A certain number of the worms already harbored die off from natural causes and are eliminated. As the worms cannot multiply within the body, the infection then automatically becomes lighter.

Thus the average infection of 200 to 300 hookworms is maintained for twenty years through the economic necessity of earning a living in

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the fields, where the laborer acquires infection, and the necessity of resting at home from his labors because of weakness, where he slowly loses infection. For the body-defense forces the battle is a losing one, however; the break in health and strength finally comes between forty-five and fifty years of age. After the latter age the average laborer in Brazil is old and broken, and to preserve his health must give up a large part of his field work and begin to wear shoes regularly.

Comparative Infection among Males and Females. A test which included 562 males and females ranging in age from five to fifty years or more, showed that children under ten

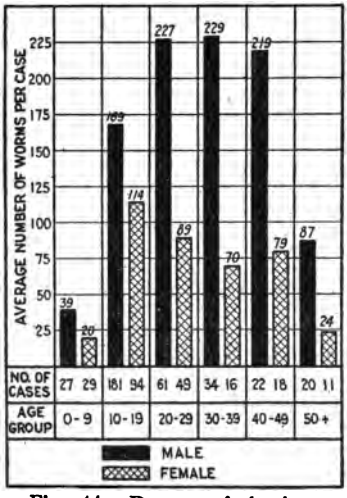


Fig. 44.—Degree of hookworm infection in relation to age and sex. Based on 562 cases. Brazil. Note that females harbor far fewer worms than males

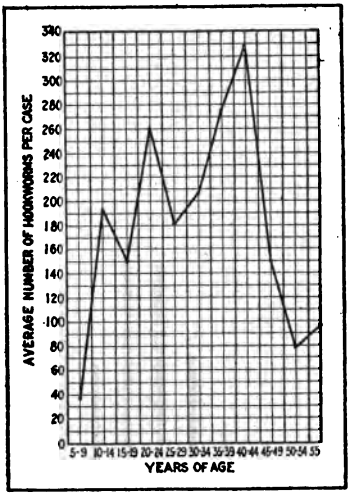


Fig. 43.—Average number of hookworms harbored, by age groups. Based on examination of 381 infected males. Brazil

years of age harbor very few worms, girls a few less than boys. The next decade showed in both sexes a tremendous increase in worm incidence, as it is the period during which the children go to work in the fields, the girls usually taking up the hoe a little later than the boys and working side by side with them. From twenty to forty-five the average number of hookworms harbored by the men remains very constant and very high, while the average number of worms harbored by the women falls after the eighteenth or nineteenth year, when they usually marry, assume household duties, and thenceforward devote but little time to work in the fields (Fig. 44).

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Hookworm Disease in Children. A special study was made of the severity of hookworm disease in children. No children under four were included in the studies and very few under six, because it is difficult to secure all the stools passed by very small children. The test included 246 infected males and 147 infected females ranging in age from four to twenty-four years, and representing all classes of society in Brazil. They were chiefly, however, the children of field laborers. In the main they had never been to school, had never worn shoes, and had always lived within a radius of five miles of their homes. The results were subdivided by sex and tabulated according to two-year age groups (Fig. 45).

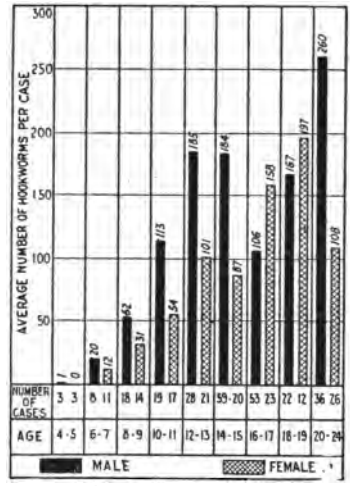


Fig. 45.—Severity of hookworm infection by sex and age groups. Based on worm counts among 393 cases under twenty-four years of age. Brazil

The number of worms harbored was shown to increase gradually and progressively as the person increased in age. Children between four and five had almost no hookworms; those from five to eight, very few. Children over eight who worked in the fields were heavily infected. Among males after the eighteenth to nineteenth year the incidence continued to rise; among females, for the reason previously explained, there was a sudden drop in the incidence.

METHOD OF CONDUCTING WORM-COUNT STUDIES

In conducting worm-count experiments a large number of individuals are registered in the communities selected for study, and their hemoglobin indices are determined with the Dare apparatus. In each community a representative group is then chosen for treatment and further study. This group usually consists of twenty-eight or thirty persons, two thirds of whom are adults over fifteen years of age and one third children from eight to fifteen. Records for each individual give the name, age, sex, occupation, and hemoglobin index; whether or not the spleen is palpable; whether there has been previous malaria or previous anthelmintic treatment; and the results of the preliminary microscopic examination of the stools for hookworm ova.

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The first treatment administered to a patient is termed the trial treatment. It varies according to the factors that are to be studied. Ten or fifteen days after the trial treatment, the test treatment is given to remove all of the hookworms that have remained after the trial treatment. An interval of this length should be allowed for the thorough excretion of the medicine administered in the trial treatment. The test treatment is always the same. It consists of a saline purge given at 8 p. m., followed the next morning by 3 mils of chenopodium administered in three equally divided doses, the first at 7, the second at 8, and the third at 9 o'clock. A final purge is given at 10:30 a. m. For children the dose of chenopodium is reduced to 1.5 mils in three equally divided portions.

To facilitate identification and to avoid confusion in handling the stools, each patient who has been treated is tagged on the wrist with a number and receives a chamber-pot which bears the same number. During the treatment careful entry is made of the hour of administration and the amount of the purge, the dosage of the anthelmintic, and the time of treatment. All symptoms, however trivial, are recorded. The entire stools are saved in the numbered chamber-pot for twenty-four hours after treatment, when the patient is given a second pot in which he saves his stools another twenty-four hours. The stools are carefully washed through No. 40 copper gauze on the day when they are received, and all the worms are picked out, counted, and classified.

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III

HOOKWORM CONTROL

There are at least two means by which treatment for hookworm disease may be made more readily available to the many million inhabitants of tropical and subtropical countries who are under the burden of a heavy hookworm infection: preliminary microscopic examination can be omitted in regions of heavy infection; and an efficient treatment can be administered as a routine, with the expectation that effective sanitation and post-campaign treatment will eliminate whatever light infection remains.

Impracticability of Insisting Upon Absolute Cure. Large numbers of worm-count studies conducted by Darling and Smillie have shown that two standard treatments (1.5 mils each) of oil of chenopodium remove an average of 95 per cent of the hookworms harbored, and that three treatments remove an average of 98 to 99 per cent of all worms. Further medication to remove the few worms that remain after two or three treatments is hardly worth the effort. Moreover, since it has been shown that diagnosis by microscopic examination fails in about 50 per cent of lightly infected cases, it is difficult to determine accurately whether any worms remain in infected persons who have taken two or more treatments. In view of these facts, several countries have adopted modified working methods to accelerate the rate of treatment.

Experimental Plan of Control for Ceylon Estates. More than 99 per cent of the Tamil laboring population of Ceylon are infected with hookworms. Preliminary fecal examination is therefore omitted in the case of all except 10 or 20 per cent of the laborers on each estate. If the specimens obtained show over 80 per cent infection, the whole labor force, except persons less than a year old, those physically unfit for treatment, and pregnant women beyond the third month, are given one or two medium doses of chenopodium with an interval of one week between. All are examined clinically beforehand to be sure that they are fit to take treatment. Ten days after the first or second treatment, fecal specimens are obtained from all those who have been treated. Persons whom the microscope indicates to be positive after two treatments are given a third treatment.

Modified Control Program in Trinidad and Papua. In certain rural districts of Trinidad where the population is so widely scattered that an intensive campaign would of necessity make its way very slowly, a modified control program has been put into operation for the purpose of rapidly reducing mass infection. A treatment center is established in each district, a census is made of the entire population, and all persons are given one microscopic examination. Those

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Fig. 46.—Staff for the relief and control of hookworm disease in Siam. Grouped at the entrance of the temple of Sankampang. Director Barnes stands fourth and Major Luang Boriracksha, a prominent figure in health work in Siam, fifth from the left of first row

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Fig. 47.—Lecture on hookworm disease for plantation laborers, Colombia. Field director exhibiting chart on porch

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found to harbor hookworms are urged to report for treatment at the community center. Four treatments are administered to each individual. No re-examinations are made, since previous experience in Trinidad has shown that four treatments (thymol is the drug commonly employed) cure 98 per cent of all patients treated.

In Papua, also, a special plan of work has been developed for extending control measures rapidly throughout the island. At the time of the initial survey of each estate an adequate number of sanitary latrines are installed and all laborers are given one treatment. The staff then moves on to the next estate, leaving a supply of anthelmintics in charge of a responsible person, who is commissioned to administer treatment systematically to all natives twice a year. It is believed that this plan will succeed in reducing mass infection, and that subsequently more intensive methods may be applied.

Modified Working Plan Tentatively Adopted for Brazil. In Brazil, too, where more than ten million people, scattered over a vast and sparsely settled area, are awaiting treatment, conservative modification has been made of the plan originally followed. This modified procedure involves a census of the community; one, and only one, microscopic examination of all persons;[1] and two treatments of oil of chenopodium administered with an interval of ten days to each infected person. Individuals with hemoglobin below 60 are treated three times without additional microscopic examination, unless malaria is a controlling factor in the anemia. In addition, all persons suffering from any form of intestinal helminthiasis whatever are treated once, as well as all the members of any family which contains even one infected individual. It is believed that this plan will reach all infected persons and succeed in eliminating at least 95 per cent of the intestinal parasites they harbor. Systematic effort is made during the treatment campaign to secure the construction of latrines at all the homes and to bring the people to understand the importance of using them as a safeguard against re-infection.

Treatment Inadequate as Sole Means of Control. Experience in many parts of the world has demonstrated that hookworm disease cannot be effectively controlled by treatment alone; if the benefits are to be other than transitory, treatment must be preceded or accompanied by adequate precautions against re-infection. This fact has been forcefully demonstrated in Ceylon, Trinidad, St. Vincent, Nicaragua, and various other countries in which control measures have been carried out. Between the years 1904 and 1910 approximately 288,000 Porto Ricans were treated for hookworm disease by the Anemia Commission under Ashford, King, and Guiteras, and striking benefits were conferred over vast areas, but there is still a high incidence of infection in Porto Rico because much

[1] In some sections of Brazil, where, as in Ceylon, there is a uniformly high rate of infection, preliminary microscopic examination is dispensed with, and treatment is carried out on the assumption that all persons are infected.

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had to be done in the way of preliminary education before sanitary measures could be introduced.[1]

The history of hookworm work in the republic of Colombia illustrates anew the necessity of accompanying hookworm treatment with preventive measures. Since 1895, spasmodic efforts have been made to relieve the infection through treatment, but they have proved at best merely palliative because of failure to insure the use of latrines. The survey conducted during 1920 brought out the fact that among persons previously treated the infection rate was still 81.7 per cent, as compared with the rate of 76.9 per cent for the general population irrespective of whether they had been previously .treated. Treatment of the people is worth while as a means of reducing mass infection and as an educational feature that may be expected to lead to the provision and use of sanitary conveniences; it is inadequate, however, as the sole measure of control.

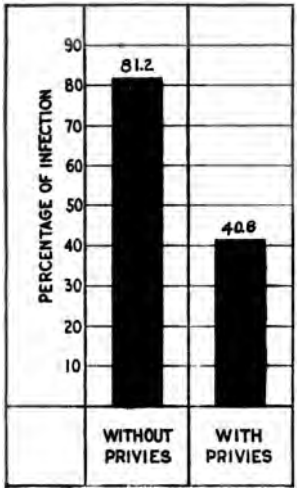


Fig. 48.—Rôle of latrines in controlling hookworm disease. Comparative incidence (based on examination of 8,465 cases) of the disease among users and non-users of latrines. Colombia

Spread of Disease Through Lack of Latrines. In Colombia, despite the fact that intermittent efforts to stamp out the disease had been going on for twenty-five years, more than 95 per cent of the rural homes were found, at the time of the 1920 survey, to be without latrine accommodation. Even in the larger towns—with the exception of Bogotá—there was no established system of night soil disposal: each householder was left to follow his own devices and many of them made not even the slightest pretense at sanitation. The feculent soil that results from such conditions forms, as one would expect, a constant menace to the public health. Of a total of 8,465 persons examined during the progress of the survey, it was found that only 646, or 7.6 per cent, were in the habit of using latrines. Among these persons the rate of hookworm incidence was only 40.8 per cent, as compared with the rate of 81.2 per cent among persons who did not use latrines (Fig. 48). Similarly, the survey of

[1] Through inadvertence, the Fifth Annual Report of the International Health Board, and lithographed report No. 7525 by Dr. John B. Grant, entitled *Hookworm Infection Survey and Malaria Survey of Porto Rico*, did not pay due tribute to the effective work of the early Porto Rico commission. Advantage is taken of this opportunity to correct the omission.

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Fig. 49.—Sanitary latrines just completed under supervision of Jefferson county health department. Suburbs of Port Arthur, Texas (see Fig. 50)

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Fig. 50.—Insanitary condition of alleys and yards in suburbs of Port Arthur, Texas, before Jefferson county health department began work (see Fig. 49)

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Santa Catharina showed that only 57 per cent of the persons who regularly used latrines were infected with hookworm disease, as compared with 87 per cent infection among the persons who did not use them.

None of the numerous tea estates visited in Madras presidency, India, were found to be provided with latrine accommodations for their laborers. Soil pollution was general on all of them and accounted in large measure for the almost universal infection among the laborers. Similarly, in rural districts lying along the littoral of Brazil, where practically all of the people are infected, it is a rare thing for the homes to be provided with latrines. Of 2,875 rural homes inspected in the district of Jacarepagua, located only fifteen miles from the Federal capital, 78 per cent were found to be without latrines at the beginning of control work; and reports from São Paulo, Paraná, Santa Catharina, and other states show similar conditions. In the town of Guaratuba in the state of Paraná, with 600 inhabitants, there was only one latrine, of the pit type. Of 1,423 homes inspected in the municipality of Aguas Virtuosas in the state of Minas Geraes, 88.5 per cent had either no privies or privies inadequate for preventing pollution of the soil.

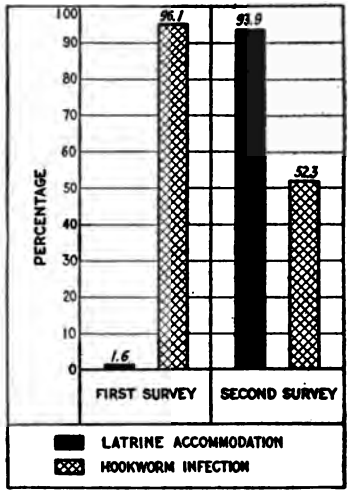


Fig. 51.—Effectiveness of latrines in preventing spread of hookworm infection, Central Mahé area, Seychelles Islands. Compare incidence of infection in first campaign, when there were few latrines, with that in second campaign, when latrine accommodation was almost adequate[1]

Recent Survey of Panama and Colon. The important rôle of sanitation in the control of hookworm infection was well brought out by work conducted during 1920 among school children in the cities of Panama and Colon. In type of soil, in elevation, and in climatic conditions these cities do not differ from the rural regions surrounding them, nor are the habits of their people essentially unlike those of their rural neighbors. From the standpoint of hookworm infection the fundamental difference lies in the fact that since the American occupation in 1904 the cities have had a modern system of sanitation.

[1] The fact that latrines are erected does not guarantee that they will be regularly used. Non-use of latrines on the part of some of the population, or failure to erect the latrines soon enough after treatment in the first campaign, may account for the 52 per cent infection recorded in the second campaign.

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Two thousand twenty-one (2,021) children were examined for hookworm disease in these cities. Of these, only 608, or 30.1 per cent, were found infected. This is in striking contrast to the rate of 99.2 per cent established during the past two years by the examination of 8,791 children in interior sections of the republic, where sanitation practically does not exist. When all children who had resided in or visited rural regions were excluded from the city statistics, there remained only 229, or 11.3 per cent of those examined, who had apparently acquired their infection within the city limits. This rate is 88.6 per cent lower than that which obtained among children in other sections of the republic.

Importance of Advance Sanitation. Nowhere has the effectiveness of adequate preliminary sanitation been better demonstrated than in the mines of Australia. Experience with hookworm disease in the mines of America and Europe had caused apprehension lest the deep and warm mines of southern Australia had similarly become infected. The Australian mines present conditions of soil, temperature, and humidity that are favorable for hookworm disease, and have derived at least a part of their labor force from regions of the earth where mine or surface infection is known to exist. Yet the examination during 1920 of over four thousand miners and mine employes in South Australia, Victoria, and New South Wales failed to reveal a single case of hookworm infection. The principal factor which has kept the mines of Australia free from hookworm is the precautions which the mine management and the miners themselves have taken to guard against soil pollution. A system of pail latrines, placed in use when the mines were first opened, has ever since been cleanly maintained and regularly used.

Government Interest in Advance Sanitation. In practically all countries where work is now under way it is not difficult to secure the installation of sufficient latrines, usually in advance of treatment. The next step—to secure and enforce a system of inspection to guarantee their continued use—is less easy. This remains after three years the outstanding problem of the work in Ceylon. The movement for advance sanitation that originated in that colony in 1917 is now making itself felt in Australia, the Seychelles, Papua, the West Indies, Central America, and Colombia. In British Guiana a budget of $100,000 annually for a period of five years has been voted for sanitary improvement and a large part of this will be spent in sanitating areas in advance of hookworm treatment; in Trinidad, £50,000 of a new £1,000,000 bond issue has been allotted for sanitation; in Grenada satisfactory sanitary work is in progress; and in Jamaica and Porto Rico definite provision has been made for preliminary sanitation and for co-operation in control measures. In all countries the practical sanitary work demanded in the hookworm control demonstrations is resulting in the upbuilding of permanent sanitary agencies.

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Fig. 52.—Excellent sanitary conditions have prevented hookworm disease from gaining a foothold in the mines of Australia. View of interior of change house, South Mine, Broken Hill, New South Wales



Fig. 53.—Surface latrine showing pails for use underground. Zinc Corporation Mine. Australia. Latrines are used by all employes, underground and surface

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Fig. 54.—Department of Soil Sanitation, Republic of Colombia

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Advance Sanitation in Colombia. Colombia is now making striking progress in securing the installation and use of latrines in advance of the carrying out of further hookworm examination and treatment. At the beginning of operations, June 14, 1920, only 3 per cent of the 51,911 homes inspected were provided with latrine accommodations of any description; on December 31, 1920, about 50 per cent of these homes were provided with satisfactory conveniences. The total latrines erected during the six-months period numbered 25,246. The plantations made an especially good showing in latrine building, many of them attaining a record of 100 per cent. Staff members were not sent to examine and treat the people in any area until all necessary latrines had been built. So ready, however, were the people to comply with the sanitary regulations that it was impossible to provide dispensary units rapidly enough to keep pace with the program of sanitation.

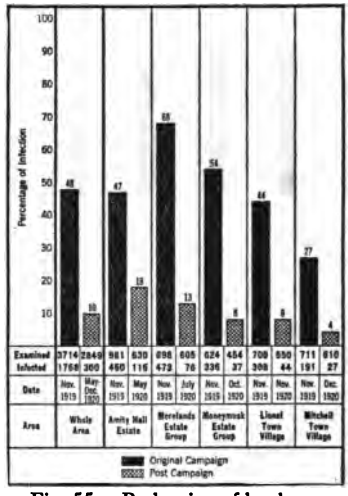


Fig. 55.—Reduction of hookworm infection on five estates of the Vere Area, Jamaica. Comparative incidence of infection in first and second campaigns

Organization of Sanitary Department in Colombia. The sanitary work in Colombia is entrusted to a permanently organized Government department vested with police powers. This division was created by special decree on February 5, 1920. Its personnel, consisting in June of two field directors and eight sanitary inspectors, had by October 15 been enlarged to include seven field directors and sixty-five sanitary inspectors. These men were divided into seven squads to operate in seven provinces, a sanitary inspector being assigned to each municipio (or district) of the province. Government makes latrine construction obligatory upon all proprietors of habitable houses. Failure to construct a latrine within twenty days after notification is punishable by a fine of from twenty to forty pesos. All members of the division have power to impose fines and to make them effective.

Advance Sanitation in Central America. In Nicaragua, at the close of the third quarter of 1920, the work entered definitely on a new phase—that of carrying out curative measures in areas where there had been advance sanitation. In the early work in this country preventive measures were out of the question. In the entire

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area where curative work was under way at the close of 1920, 75 per cent of the homes had been provided with a good type of latrine at least six months in advance of the opening of the work. The area wherein operations will be conducted during the first six months of 1921 has already accomplished 90 per cent of privy construction.

In Panama, too, there has been developed a new plan of work whereby the entire staff will be concentrated in one province and sanitary construction will precede treatment. In Salvador the staff has endeavored so far as possible to precede relief measures by sanitary campaigns especially related to the construction of latrines. While progress in the latter country during 1920 has been somewhat slow, it has nevertheless been distinctly more encouraging than in former years. It is unfortunately still necessary to begin curative measures when only three fifths of the homes in an area are provided with latrines, but the provision of even three fifths of the homes with sanitary conveniences is a step in the right direction and the proportion may be increased as time goes on.

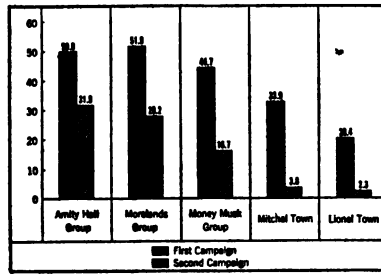


Fig. 56.—Reduction in severity of hookworm infection following control measures. Infected persons who required *more* than two treatments to cure, first campaign and second campaign compared. Five estates of Vere Area. Jamaica

Sanitary Progress in Brazil. Of the eighteen Brazilian areas in which co-operative control demonstrations were carried out in 1920, satisfactory sanitary progress is reported from only four: Jacarepagua in the Federal District, Guaratuba in the state of Paraná, and Itajahy and Florianopolis in the state of Santa Catharina. In the municipality of Jacarepagua all houses near small centers of population now have latrines. The only houses remaining unsupplied are scattered widely throughout the hills on the outskirts of the area. The intensive work in this district closed on June 30, but the sanitary work continues and a permanent force of sanitary inspectors will be maintained indefinitely. By the end of 1921 it is hoped that all permanent habitations in the district will be provided with latrines of one type or another. In the state of São Paulo Government has adopted a sanitary code and will inaugurate at once active efforts to enforce it. Past progress here has been due mainly to the effort of owners of coffee farms, who, oftentimes in advance of the treatment campaign, have made provision for installing latrines.

Reduction of Hookworm Infection. With a view to determining the degree of success achieved by measures for the control of

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Fig. 57.—Durable and efficient type of public latrine. Bucket system with concrete superstructure. Heneratgoda, Ceylon. (Note cooly scavenger at work)

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Fig. 58.—Well built pail latrine and incinerator. Ceylon



Fig. 59.—Excellent type of pit latrines for estates. Kept lighted at night. Ceylon

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hookworm disease, re-surveys have been made from time to time of areas in which operations had been conducted in earlier years. The re-surveys conducted during 1920 in Jamaica and in the county of Escasú, Costa Rica, showed that control operations had effected substantial reductions in the incidence of the disease. On the Vere Estates in Jamaica, at the time of the original campaign in November, 1919, the rate of infection was 48 per cent; at the time of the re-survey in 1920 it was only 10 per cent (Fig. 55, page 85). The infection rate in the county of Escasú was 59 per cent in 1917; in 1920 re-examination of ninety-three persons whose treatment had been completed three years earlier showed an infection rate of 32 per cent—a reduction of 27 per cent.

Twelve representative counties of four southern states were also re-surveyed in 1920. The statistics indicate that the average infection rate of 59.7 per cent which prevailed at the time of the initial survey in 1911 had been reduced to 21.7 per cent at the time of the re-survey in 1920—a reduction of 38.0 per cent (Fig. 16, page 29).

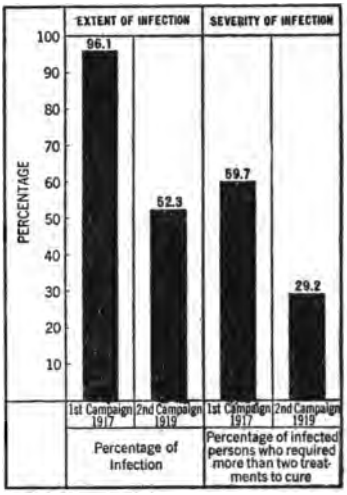


Fig. 60.—Reduction of infection in Seychelles Islands. Incidence of infection in first and second campaigns compared. The lightness of the infection in the second campaign will be seen by comparing the two bars to the right, which indicate the percentage of infected persons who required more than two treatments

Persons found on a second survey to be re-infected with hookworms harbor a much smaller number of worms than they harbored at the time of their first treatment. Of 286 re-infected persons treated during the second campaign on the Vere Estates in Jamaica, 78 per cent were freed of worms by two treatments, and in not a single instance were more than four treatments necessary (Fig. 56). In the first campaign in this area, on the other hand, the treatment of only 58 per cent of the patients was completed by two treatments, and in some cases it had been necessary to give as many as ten treatments. In the Seychelles Islands, again, 70.8 per cent of the total number of persons freed of worms in a re-campaign were relieved of their infection by two treatments, as compared with only 40.3 per cent in the first campaign one and one-half years earlier (Fig. 60).[1]

[1] All of these re-survey figures are based on search with the microscope for eggs in the feces.

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IV

DIAGNOSIS AND TREATMENT OF HOOKWORM DISEASE

Hookworm infection may be diagnosed by administering a vermifuge and searching the stools for hookworms, or by omitting the vermifuge and microscopically examining specimens of feces for ova. It has been customary in field work to rely almost wholly upon variations of the latter method. There are culture methods by which the presence of the infection may be demonstrated, but these are hardly practicable for field use.

DIAGNOSIS BY MICROSCOPIC EXAMINATION

In areas where less than 85 per cent of the people are infected, it is desirable, before administering treatment, to determine whether the infection is present by microscopically examining the feces. Several means of making the examination have been developed, of which the simplest is the plain smear method. This consists of mixing on a two-by-three-inch slide a small portion of fecal matter with a few drops of water, and examining by low power magnification three films made from the mixture.

A more accurate diagnosis can be made with the aid of the centrifuge. When this method is used, a portion of the fecal specimen is thoroughly stirred in a metal cone with five times its volume of water and allowed to settle for a few minutes. Then the supernatant fluid, with ten times its volume of water, is poured into a centrifuge tube and centrifuged rapidly for five minutes. At the end of this time slides for examination with the microscope are prepared from the deposit on the cork of the tube.

Methods of Detecting Ova in Lightly Infected Specimens. Both the plain smear and the centrifuge method, though reasonably dependable when large or moderate numbers of hookworms are harbored, fail to diagnose accurately a considerable proportion of light infections. The need for a microscopic technique which would succeed where these fail has led to the development of a number of methods which secure the concentration of a large number of ova on a slide.

a. Lane levitation method. Clayton Lane recommends a technique which he designates as the levitation method. In this procedure the concentrated sediment of a centrifuged specimen is transferred to a

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glass slide, where it is mixed with one mil of water. The slide is allowed to stand for five minutes and is then immersed in water and manipulated until all coarse matter has floated free. The hookworm ova stick firmly to the slide and are not washed away. Lane reports that on an average this method results in a ten-fold concentration of ova.

b. Glycerine-salt method. Barber in the course of his work in the Federated Malay States developed what is known as the glycerine-salt method of examination. In this the fecal specimen is diluted with a fluid composed of equal parts of glycerine and a saturated solution of magnesium sulphate. The mixture is thoroughly stirred and broken up with a toothpick, a process which releases the hookworm ova and causes them to rise to the surface. When the upper part of the fluid in each container is placed on a slide, a large number of ova are brought under the lens of the microscope.

c. Brine flotation-loop method. Kofoid and Barber during their work with the United States Army achieved good results with the brine flotation-loop method of examination. This process demands that a large fecal sample be thoroughly mixed with concentrated brine in a paraffin paper container of from fifty to seventy-five mils (two to three ounce) capacity. The coarse float is forced below the surface by means of a disk of steel wool, and the container is allowed to stand one hour. The upper film is then lifted off with a wire loop one-half inch in diameter and transferred to a slide for examination. The great advantage of this method is believed to lie in its easy utilization of large samples. It eliminates to a large extent the element of random sampling and insures a sufficient number of ova on the slide to make detection possible even when the infection is so light that the ova would be overlooked by other methods using smaller samples.

d. Willis levitation technique. Willis has developed a simplified levitation method which requires no apparatus other than the microscope. This procedure calls for the removal, from the tin in which the fecal specimen has been collected, of enough of the specimen to leave the container not more than one-sixth full. A saturated solution of coarse table salt is then added drop by drop to the specimen until the container has been filled to the brim. The mixture is thoroughly stirred and allowed to stand for a few minutes to permit the ova to rise. A clean polished slide is then placed on the container in contact with the surface of the fluid. In a short time the ova adhere to the slide, which is then removed and placed under the microscope for examination. The advantage of this method lies in its rapidity and in the fact that it secures a good concentration of ova with the use of a small specimen—a factor which makes it suitable for use in field work, especially in remote districts where specimens have to be carried on horseback for many miles.

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DIAGNOSIS BY ADMINISTRATION OF VERMIFUGE

The most accurate method of diagnosing hookworm infection is by administering vermicidal treatment and examining the stools for worms. This method is of especial value for determining both the type and the number of hookworms harbored. It is not, however, practicable as a routine field measure. To diagnose infection by this method, it is customary to administer treatment according to the routine method and to save all stools passed by the patient for the succeeding seventy-two hours. The patient should be restrained from eating vegetables with coarse fibres during this period, as these, when passed with the stools, may interfere with the search for worms.

Method of Washing Stools. A regular routine is followed in washing the stools. Those that are soft or fluid are washed at once; the more compact stools are mixed with water and stirred until soft. The washing is done by means of a jet of water played with moderate force into a large brass wire sieve (mesh fifty to an inch) into which the feces have been poured. The washed stool is distributed into photographic developing trays, a small portion into each tray. A dark brown tray furnishes the best background for the worms. The worms are then picked out with needles or with forceps and placed in properly numbered Petri dishes containing normal salt solution. Later the excess salt solution is drained off, and the worms are killed by flooding the dishes with boiling alcohol (70 per cent). After the worms are scalded, they become rigid and assume shapes that are characteristic of their species. This renders differentiation comparatively easy and permits rapid counting of the worms.

TREATMENT OF HOOKWORM DISEASE

Chenopodium is now the definitely preferred anthelmintic for treating hookworm disease. However, it sometimes has an injurious effect upon persons to whom it is administered. Alarming symptoms, and on rare occasions deaths, have been reported from various areas following the administration of the drug in accordance with accepted methods of treatment. Children are especially susceptible to its toxic qualities. Of ten fatalities from chenopodium reported in Brazil during the Board's four years of work in that country, all but one occurred among children ten years of age or less. In Colombia during 1920 seven deaths, all of which were among children, occurred after treatment with chenopodium. It is essential, therefore, that medical officers exercise careful supervision over the use of the drug in the field and that they prescribe for children a dosage smaller than is indicated by Young's rule.

Standard Method of Administering Chenopodium. The standard method of administering chenopodium in field work is that

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Fig. 61.—Demonstrating the actuality of hookworms to native peoples. Group awaiting turn to view the worms with the microscopes. Sankampang, Siam

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Fig. 62.—Training microscopists for field work. La Mesa, Colombia. Hookworm control operations were inaugurated in this country during the year

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recommended by Darling and Smillie as a result of investigations in the Federated Malay States and in Brazil. It consists of an adult dose of 1.5 mils administered in freshly filled hard gelatine capsules. The drug is given in two equal portions, one at 6 a.m. and one at 8 a.m. The last capsule is followed in two hours by a saline purge. No preliminary purge is given. The patient is allowed no food from 8 p.m. of the day preceding treatment until after the prescribed medication has been administered and the purge has acted well. At 7 a.m., however, a small cup of black coffee may be permitted. For children the dosage of chenopodium is graded according to age: those between five and eight years receive one drop of the vermifuge for each year of age; those over eight years are given two drops for each year. The dropper employed is so graded that thirty drops equal one mil.

In the Brazilian experiments one treatment according to this method was found to remove 83 per cent of all hookworms present, and two treatments approximately 95 per cent. The treatment is easily and cheaply administered and produces very little discomfort.

Efficiency of Chenopodium in Undivided Doses. Darling and Smillie found that in so far as single treatments were concerned, the best results were obtained when chenopodium was administered in an undivided two-mil dose, preceded by a saline purge on the evening before treatment and followed two hours after treatment by a similar purge. With this technique 93.8 per cent of the worms harbored were removed by one treatment. Under hospital or dispensary conditions this technique may be employed as easily and as cheaply as the standard method recommended for field use. It causes less discomfort to the patients than other methods, and by its provision for the rapid elimination of the drug it entails less danger of toxic symptoms. It is not, however, adapted to field conditions, especially in sparsely settled rural communities where the administration of a preliminary purge is a difficult and expensive procedure.

Omission of Preliminary Purge with Oil of Chenopodium. Many authorities hold that better results are obtained from chenopodium if a pre-treatment purgative is given. The field experiments of Darling and Smillie, however, have indicated that a preliminary purge, instead of adding to the efficiency of a divided 1.5-mil dose of chenopodium, *slightly* diminishes it in the case of adults. This dosage preceded by a purge was found to remove 90.7 per cent of the worms present, whereas without the preliminary purge it removed 91.0 per cent of all worms. There was relative failure of treatment[1] in 35 per cent of the cases receiving a preliminary purge and in 21 per cent of the cases not receiving one. When smaller doses of chenopodium were given, as in the treatment of children, preliminary purgation *greatly* lowered the efficiency of the drug. A dose of .6 mil preceded by a purge removed only 70.6 per cent of the worms har-

[1] In these experiments a treatment was considered to have failed if it left the patient with ten or more worms.

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bored; with preliminary purgation omitted it removed 85.6 per cent. Treatment failed in 100 per cent of the cases receiving a preliminary purge and in only 33 per cent of those not receiving the purge.

When a preliminary purge is administered under field conditions, it frequently so weakens the patient as to unfit him for work the next day, thereby greatly prejudicing him against treatment. Often it causes extreme prostration. In sparsely settled areas its administration is difficult and almost doubles the cost of treatment. It seems advisable therefore to omit preliminary purgation in field work. This was done during 1920 in Brazil, Ceylon, Australia, Salvador, and Guatemala. In none of these areas were there any ill effects or any decrease in the percentage of cures.

Effect of Preliminary Abstinence from Food. Authorities as a rule advise a very light diet during the twenty-four hours preceding treatment. Theoretically, abstinence from food for from fifteen to twenty hours before chenopodium administration should, by leaving the intestinal tract empty, greatly enhance the efficiency of the vermifuge. Field experiments conducted by Darling and Smillie, however, have shown that by far the best results from the chenopodium are obtained when patients are allowed their usual diet on the day before treatment but no food on the morning of treatment. When this procedure was followed and the preliminary purge omitted, 91.0 per cent of the worms harbored were expelled by one treatment (1.5 mils). When patients were allowed no solid food after 11 a.m. of the day before treatment and no nourishment of any kind after 5 p.m., and when the preliminary purge was omitted, one treatment removed 90.1 per cent of all worms. Among persons from whom food was withheld, treatment failed in 60 per cent of all cases, while among those who received an ordinary diet on the day before treatment, there were only 21 per cent of failures. Moreover, prostration and severe toxic symptoms were universal among persons who did not receive food.

In the case of children, who received small doses of the drug, only 35.6 per cent of all worms were removed when food was withheld, and there were 100 per cent of treatment failures; among children who were allowed an ordinary diet, 85.6 per cent of all worms were expelled and there were only 33 per cent of treatment failures.

In field work conducted in Ceylon and the Seychelles Islands, also, it was found that patients who ate an ordinary meal on the afternoon before treatment were much less apt to suffer collapse after the administration of chenopodium than those who were limited to a light repast. Furthermore, there was no diminution in the percentage of cures when a regular diet was permitted.

Simultaneous Administration of Food and Chenopodium. A series of experiments were made by Darling and Smillie during 1920 to determine the effect of administering food coincidently with chenopodium. Patients undergoing this test were subjected to no

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Fig. 63.—Group of village headmen assembled to hear a lecture on hookworm disease. Ceylon

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Fig. 64.—Eager listeners to chart lecture at Parnassus Creole Barracks. Jamaica

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diet restrictions on the day before treatment and received no preliminary purge. On the morning of treatment they received .75 mils of chenopodium at 6 a.m. Between 6:30 and 7 a.m. they were allowed 250 mils of milk, 100 mils of coffee, and 200 grams of bread. At 8 a.m. they received a second .75-mil dose of chenopodium and at 10 a.m. a saline purge. This procedure caused no toxic symptoms nor even the mild discomforts which usually attend treatment with chenopodium, but it greatly lowered the efficiency of the drug. It removed only 56.2 per cent of all worms harbored and failed in 58 per cent of the cases treated.

Magnesium Sulphate Most Commonly Used Purgative. The question as to the best purge for use in connection with hookworm treatment has not been definitely settled. The one most extensively used is magnesium sulphate. The rapidity of action of this purgative has been found to vary in inverse proportion to its concentration. Experience in Ceylon has shown that when a strong solution is administered, catharsis is often delayed until evening of the day of treatment, or even until the next morning. A weaker solution (two pounds of salt to a gallon of water, or about one and one-half drams to the ounce) gives much prompter action and is less apt to cause griping or collapse. The most satisfactory dosage of this weaker solution of magnesium sulphate appears to be two and one half ounces for adult males and two ounces for adult females.

Compound Jalap Powder an Efficient Purge. Washburn reports that in his recent work in Jamaica he used compound jalap powder with much success as a substitute for magnesium sulphate. The drug was given in capsule form, both as a preliminary purge and coincidently with the vermifuge. For the preliminary purge it was mixed with a small amount of powdered charcoal and administered to adults in doses of thirty to forty grains.[1] In the treatment capsule it was compounded with thymol in the same manner and same amounts as milk sugar or bicarbonate of soda. When chenopodium was used, the jalap was placed in the capsule and the oil was dropped upon it. As a preliminary purge, compound jalap powder does not act so rapidly as magnesium sulphate; it can therefore be given on the afternoon instead of the evening preceding treatment, and the nurse is saved the necessity of visiting his patients at night. A final purge is not required when jalap is added to the treatment capsule, and an extra dose of purgative is not found necessary in so many instances as when a single dose of magnesium sulphate is given after vermifuge treatment. The powder is cheaper than magnesium sulphate, easier to administer, and not disagreeable to take.

Castor Oil Used Successfully with Chenopodium. Many authorities have found castor oil a satisfactory purge for use with

[1] The powdered charcoal was mixed with the jalap used in the capsule given for the preliminary purge in order to darken the capsule and thus render it easily distinguishable from the treatment capsule of thymol and jalap.

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chenopodium. Salant's experiments showed that the resistance of animals to the toxic effect of chenopodium was much greater when the drug was preceded by a dose of castor oil. Quantities of chenopodium which invariably caused the death of animals when administered without castor oil, were received without symptoms of poisoning when the oil was given shortly before or after the vermifuge. Hall and Wigdor in their experimental treatment of 220 dogs found that when castor oil and chenopodium were administered simultaneously, good purgation was obtained and a high degree of protection was secured against gastro-intestinal irritation and the toxic effects of the vermifuge.

In Nicaragua during 1920 Molloy compared the cases receiving magnesium sulphate after chenopodium with those receiving castor oil. The latter group experienced practically no serious after-effects; in the former, severe symptoms were common. Persons suffering from inanition frequently experienced extreme prostration after taking magnesium sulphate. Following these observations Molloy administered, to all hookworm patients who showed evidence of severe debility, castor oil before, with, and after chenopodium. In less extreme cases of debility he administered chenopodium in half an ounce of castor oil, and gave a small dose of magnesium sulphate two hours after the last dose of vermifuge. Furthermore, he gave a dose of castor oil immediately to all persons who presented symptoms of poisoning following treatment with chenopodium.[1] No serious cases of poisoning occurred after the institution of these measures.

Standard Technique of Thymol Administration. In the countries where thymol is used, the dosage most commonly employed is that recommended by Stiles, Dock, Howard, Bass, and others of wide experience in the treatment of hookworm disease. It is based upon sixty grains as the maximum for an adult, preceded and followed by an active saline purgative. Children from one to five years of age receive from three to five grains of the thymol; those from six to ten, from ten to fifteen grains; and those from eleven to fifteen, from fifteen to thirty grains. Persons between sixteen and twenty years of age receive from thirty to forty grains; those between twenty-one and fifty years, from forty-five to sixty grains; and those more than fifty years, from thirty to forty-five grains. The drug is usually administered in finely powdered form, mixed with equal parts of milk sugar or sodium bicarbonate. It is given in two equal portions, and apparent—not actual—age determines the dosage. Competent physicians examine all patients who are to take the drug, prescribe

[1] It is worth noting, however, that Darling, Barber, and Hacker have reported an experience directly the opposite of that indicated by Salant's, Hall and Wigdor's, and Molloy's results. In their investigations in the Orient they found that when castor oil was used with chenopodium, there was a noticeable increase in dizziness, deafness, and other toxic symptoms, as compared with the symptoms that resulted when magnesium sulphate was used.

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the proper dosage for each, and supervise the important phases of treatment.

Conditions Governing Administration of Thymol. Food is not allowed from the time of the first purgative until after the final dose of salts has acted. Inasmuch as alcohol and oils, and gravy, butter, milk, and other fatty foods, are especially dangerous, the patient is cautioned against taking them at any time during the period of treatment. Under field conditions it is generally held that thymol should not be administered to persons suffering from acute diseases, such as malaria in the febrile stage or fevers of any other type; to those having chronic dysentery or diarrhea, organic cardiac or renal disease, pulmonary tuberculosis beyond the incipient stage, or general anasarca; to those who are extremely weak or feeble from old age or from other cause; or to pregnant women or women with serious hemorrhagic diseases of the uterus. Thymol may be administered to persons suffering from any of these diseases only when the circumstances will permit rigid control of all features connected with the treatment.

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V

OPERATIONS AGAINST YELLOW FEVER

During 1920 co-operative work against yellow fever was undertaken in Mexico; aid was given in the suppression of epidemics in Central America, in Brazil, and in Peru; sanitary surveillance was maintained to guard against a recurrence of the infection in Guayaquil, Ecuador; and the presence of the disease in West Africa was investigated. Work against yellow fever was therefore under way in every region in which it is known to exist, and steady headway is being made toward its control.

Mexico Undertakes Co-operative Anti-Stegomyia Campaign. Upon invitation of Government a co-operative program for the control of yellow fever in Mexico was adopted toward the close of 1920. A decree issued by the President shortly after the arrival in Mexico City of Colonel T. C. Lyster, director of yellow fever work in Mexico and Central America, authorized the inauguration of control measures throughout the infected districts, provided for the creation of a special yellow fever commission, and set aside 50,000 pesos for carrying out the work. All control operations under the new plan are to center in the Mexican Department of Health. The American personnel will regard themselves as representatives of this department.

During the last six months of 1920 yellow fever existed in Mexico from Tampico to Progreso in the east, and from Hermacilla to Tapachula in the west. This epidemic was checked under the able direction of the national Board of Health. The first efforts under the new co-operative program will be directed toward the points of greatest importance. Late reports indicate that in the first area inspected, a zone 150 kilometers in diameter with Vera Cruz as its center, the incidence of the disease is low.

Yellow Fever Eradicated from Guayaquil. One of the outstanding features of the yellow fever situation in 1920 was the official announcement made in July by the Director of Health of Ecuador that the disease had been entirely eradicated from that country. The infection, which had been present in Guayaquil since 1842, was brought under complete control in that city in June, 1919. Since then no vestige of it has reappeared, and there is every reason for believing that it has been permanently suppressed (Fig. 65). With the disappearance of yellow fever from Guayaquil it is believed that the last endemic focus of the disease in Ecuador has been eliminated. A modern water-supply system is being installed in Guayaquil. Until such time as it is in operation, Government inspectors will guard against a recurrence of Stegomyia breeding by maintaining strict supervision of all water containers. On November 29, 1920, Govern-

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ment assumed full responsibility for the continued maintenance of the work, and the Board's representative withdrew from the country.

Reappearance of Yellow Fever in Central America. In Central America outbreaks of yellow fever occurred during 1920 in Salvador and Guatemala. A few sporadic cases were reported in Nicaragua. In Salvador the disease was first detected in the coastal plain city of Sonsonate, where a large military detachment recruited from all parts of the Republic had been gathered to suppress a threatened revolution. Many of the recruits had come from high altitudes and were therefore non-immunes. Between May 22 and August 21 there were fifty-six known cases of yellow fever in Sonsonate. The city was placed under strict quarantine, but despite this precaution the disease spread to seven other towns in the department of Sonsonate, to the neighboring departments of Santa Ana and La Libertad, and to Usulután. Meanwhile, smoldering foci of infection which had existed in the city of San Salvador as an aftermath of the epidemic of 1919 flared forth, and the disease spread rapidly to many sections of the city. In the course of the year twenty-five localities of the country were visited by yellow fever, and 181 cases in all were reported (Fig. 68, page 106).

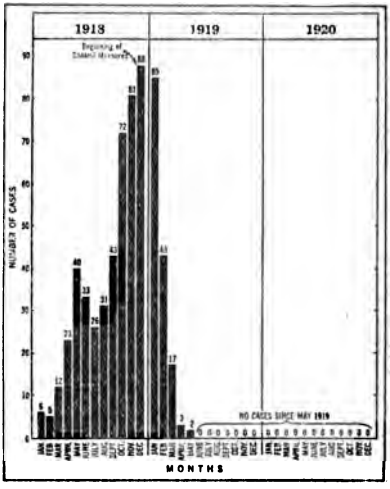


Fig. 65.—Incidence of yellow fever in Guayaquil, Ecuador, 1918–1920. The disease has been completely eradicated from that city as the result of anti-mosquito measures instituted there in November, 1918. Since May, 1919, there has not been a single case

In Guatemala the disease appeared in early June at Los Amates, whither it had probably been carried by an itinerant peddler from Sonsonate. Between June 5 and September 11 fifteen cases were reported. Later nine cases appeared in La Democracia, five in Zacapa, and one in Virginia.

Control Measures in Central America. The health authorities of Salvador and Guatemala at once put forth every effort to suppress these outbreaks, so that by the end of the year yellow fever had almost entirely disappeared from both countries. To insure protection against its recrudescence, anti-mosquito measures will be continued in every area of infection for at least a year after the ap-

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pearance of the last case of the disease. Fish control will play a prominent part in these operations.

In Nicaragua and Honduras protective anti-mosquito work was carried on throughout 1920 to guard against outbreaks of yellow fever. During the coming year these precautionary measures will be continued. The Central American countries have taken a determined stand against yellow fever. It seems that their earnest efforts to control the infection must in the end win out.

Suppression of Epidemic in Peru. The elimination of yellow fever from Ecuador left only one center of infection on the Pacific coast of South America—the province of Piura in northern Peru.

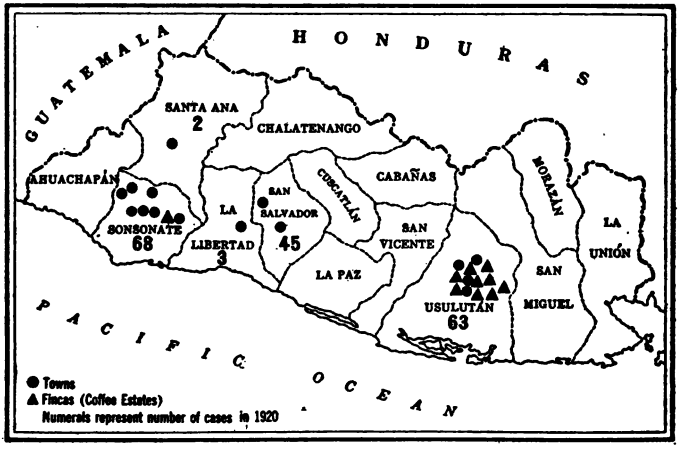


Fig. 66.—Map of Salvador showing location of yellow fever cases in 1920 epidemic

An epidemic of the disease had broken out in that region early in 1919 and had spread to at least ten towns by 1920. The incidence of the infection and the death rate were high. Under the direction of Dr. Henry R. Carter, the Government health service organized energetic measures for the control of Stegomyia breeding throughout the area, and at length succeeded in reducing the Stegomyia index below the danger point. As a result yellow fever had disappeared from the province by the end of October, 1920.[1]

Controlling the Infection in Brazil. While measures were under way for eradicating yellow fever from the west coast of South

[1] In February, 1921, yellow fever reappeared in Peru at a point south of the region previously infected. The disease crossed the desert from Piura and broke forth in several of the rather densely populated coastal towns of the department of Lambayeque. The Board is co-operating with Government in control measures which are being conducted under the direction of Dr. Henry Hanson.

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Fig. 67.—Colonel T. C. Lyster, of the Board's yellow fever staff, administering Noguchi yellow fever vaccine. Los Amates, Guatemala

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Fig. 68.—Receptacles such as these were a favored breeding place of yellow fever mosquitoes at beginning of control effort in Guayaquil, Ecuador. Fish effectively prevented breeding in practically all these and other miscellaneous water containers

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America, the public health service of Brazil was engaged in fighting the infection in the sections of that country where it still persisted. Early in 1919 epidemics of the infection had broken out in six of the northern states of the country. Government organized a central yellow fever commission for combating these outbreaks, and each state where the disease existed appointed a body with similar functions. The various measures which these organizations pursued for reducing the Stegomyia index throughout the infected regions resulted by the end of 1920 in yellow fever in epidemic form being entirely suppressed, and in endemic form being confined to the narrow strip of coastal area between Bahia and Pernambuco. Outbreaks of the disease which occurred in the states of Pernambuco and Sergipe during 1920 were soon controlled, and during the last four months of the year no verified cases were reported from any part of the Republic.

Pursuit of Yellow Fever in Africa. During 1920 a commission visited the west coast of Africa to investigate the nature of a disease which has prevailed in that region for some time and has frequently been reported as yellow fever. The commission, composed of R. E. Noble, M. D., Assistant Surgeon General of the United States Army; Juan Guiteras, M. D., Director of Public Health of Cuba; Adrian Stokes, M. D., Assistant to the Professor of Pathology, Trinity College, Dublin; A. E. Horn, M. D., of the West African Medical Service; and W. F. Tytler, M. D., of the staff of the Medical Research Council in Great Britain, arrived in Lagos, Nigeria, July 17. Here it established headquarters and opened a laboratory. From this point the members carried their investigations into Nigeria, Dahomey, the Gold Coast, Senegal, and Matadi in the Belgian Congo.

Further Study Required to Determine Presence of Infection. A study of such vital statistics and records of epidemics as were available in these localities indicated that yellow fever, or an infection closely allied to it, had existed endemically and epidemically for many years. For the period from May, 1915, to May, 1920, a total of eighty-six cases of yellow fever were reported in the British West African colonies alone. There were also records of epidemics in Dahomey at various times during the period from 1905 to 1917. In the Belgian Congo an outbreak was reported in 1917.

The commission remained in the West Coast area for a period of only fifteen weeks. During the brief time at its disposal it saw no authentic cases of yellow fever, nor was it able to observe any cases of a disease known locally as "shaura," which is reported to exist among the natives and to produce in its acute stages symptoms suggestive of yellow fever. To establish definitely whether this disease is or is not yellow fever, and whether, if it is not, yellow fever is present at all, will require a longer period of time and better facilities for investigation than the commission had at its disposal. Indeed, the task of tracking down yellow fever in this area is likely to prove

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a most arduous one and to require prolonged local residence. It will involve following clues to the disease into native villages far from the coast and covering tremendous distances in sections where horseback, hammock, and walking are the only means of travel. The tendency of the natives to hide all cases of disease from the authorities will also complicate the problem. The commission has recommended that another body of investigators be sent to undertake this difficult study and to suggest definite measures for the suppression of the disease if it is found to exist.

Use of Vaccine and Serum in Yellow Fever Control. *Leptospira icteroides* was first isolated by Noguchi in 1918 from cases of yellow fever in Guayaquil. Later (1919) the organism was obtained from yellow fever cases in Merida, Yucatan, and again (1920) in northern Peru by Noguchi and Kligler. Gastiaburu transmitted yellow fever to animals in Piura in 1919. Perez-Grovas, working in Vera Cruz, Mexico, during the summer of 1920, reproduced yellow fever in guinea pigs and obtained a culture. Le Blanc, of the Rockefeller Institute staff, also obtained a strain of the organism from a case of yellow fever in Vera Cruz (1921). The strains obtained by Perez-Grovas and Le Blanc have been found to be identical with the *Leptospira icteroides* isolated earlier.

The killed cultures of *Leptospira icteroides* were first used for protective inoculation against yellow fever in Guayaquil in 1918, where 427 vaccinations were carried out. The results were so encouraging (the morbidity rate among vaccinated and unvaccinated during the same period being 11 and 110 per thousand, respectively) that a vaccine several hundred times as strong has been made in large quantities and employed in Mexico by Drs. Vasconcelos and Casasus of the Consejo Superior de Salubridad; by Drs. Lyster, Bailey, and Vaughn in Central America; and by Drs. Lynn and Guadarrama in Tuxpan, Mexico. The total number of non-immune persons reported vaccinated is about 8,000. The development of protection, as in the case of other vaccines of this sort (anti-typhoid, for example), requires about ten days for completion, persons exposed to yellow fever just before vaccination or immediately afterwards not being protected by vaccination. Excluding such instances, however, there has been no case of yellow fever among the 8,000 persons vaccinated in the various localities, while among unvaccinated persons during the same period and in the same areas there have been about 700 cases of the disease.

The vaccine, by providing immunity, furnishes a rapid method for reducing the number of non-immune persons in areas where yellow fever is epidemic. By the application of sanitary measures to eliminate the mosquito carrier and of vaccination in the meantime to cut off from the infected mosquitoes the supply of non-immune material, a threatening epidemic of yellow fever in Guatemala and Salvador in 1920 is reported to have been checked within one month from the appearance of the first cases; that is, before a second set of cases had

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developed. The value of vaccination as an emergency measure does not, however, minimize the importance of the anti-mosquito operations, the elimination of both factors—the non-immune human being and the infected mosquito—being useful in the control of yellow fever.

A therapeutic serum is also available for the treatment of yellow fever. It has already been employed in 152 cases by Drs. Lyster, Vaughn, and Bailey in Central America; by Drs. Vasconcelos and Casasus, Lynn, and Guadarrama in Mexico; and by Dr. Hernandez of the Junta de la Sanidad de Yucatan. Persons treated before the third day of illness have almost invariably recovered, the exceptions being those cases in which the quantity of serum used was too small to have any effect. After the fourth day of illness the injuries to organs are so great as to be irreparable in severe cases of yellow fever. By the use of the serum the usual mortality in yellow fever, 50 to 60 per cent, has been reduced to 9 per cent.

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VI

COUNTY HEALTH WORK

In the Southern States demonstration campaigns in the control of hookworm disease have greatly stimulated the development of full-time county health organizations. These agencies seek to do for the rural people what the modern, well-equipped municipal health department does for the population of the larger towns and cities. The importance of this work will be appreciated when it is remembered that 54 per cent of the total population of the United States is rural, and that in twenty-five of the states the rural population comprises more than three fifths of the total.

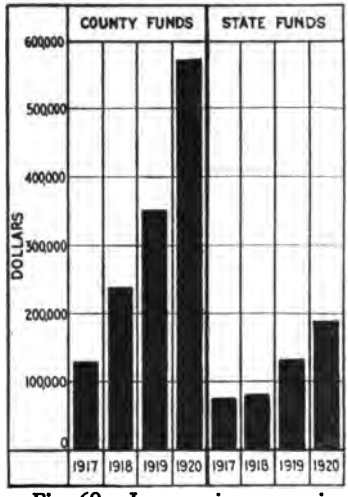


Fig. 69.—Increase in appropriations for county health work. Southern States, 1917–1920

Ninety-seven counties in twelve southern states had, at the close of 1920, full-time health departments. Interest in public health matters has been stimulated, the people are voting taxes as never before for health purposes, and a sanitary sense is beginning to manifest itself. The marked increase in state and county appropriations is exhibited in Fig. 69.

In one of the states county health work has been in progress for more than three years. At the close of 1920 work of this kind was being conducted in twenty-four of its counties having a combined rural population which represented 33 per cent of the state's rural population. A summary of the results accomplished in these twenty-four counties shows 28,345 persons examined and 5,469 treated for hookworm disease; 96,739 vaccinated against typhoid fever and 36,810 against smallpox; 13,670 cases of infectious diseases quarantined; 77,573 school children and 5,780 adults examined for physical defects; and 2,354 public health meetings held, at which the total attendance was 253,488. In addition, 23,547 privies at rural homes were either constructed anew or improved to meet the requirements of the state board of health.

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Monthly Report of _____ County
to the
STATE BOARD OF HEALTH

February 1920

EDUCATIONAL		QUARANTINE			NURSES' REPORT (General)	
Public meetings	10	Cases quarantined		81	Number on duty	
Attendance	727	Whooping-cough	REPORTED	13	Lectures	
Letters sent	757	Measles–German Measles		28	Attendance	
News articles (original)	5	Diphtheria–S.S. throat		1	Office visits	
News articles (press)		Smallpox–Chickenpox		7	Assistance to H.O hours	29
Office conference, hours	8	Typhoid–Para typhoid		2	News articles	
Pieces of literature		C.S.Meningitis–Inf. paralysis			Letters sent	
SOIL POLLUTION		Trachoma–Ophthal. neonat.			**INFANT HYGIENE**	
Sanitary privies, rural	317	Venereal disease			Clubs organized	
Sanitary privies, towns		Scarlet fever		1	Clubs visited	
Specimens, stools examined	1	Influenza			Demonstrations	
Having hookworm		Whooping-cough	VISITED		Conferences, personal	18
Treatments given		Measles–German Measles		18	Cases visited–mother	
Cured of hookworm	22	Diphtheria–S.S. throat		1	Cases visited–child	
Workers employed		Smallpox–Chickenpox		6	Midwives instructed	13
Days worked, total		Typhoid–Para typhoid			Furnished silver nitrate	
Water supplies improved		C.S.Meningitis–Inf. paralysis			Schools visited	
SCHOOLS		Trachoma–Ophthal. neonat.			Children examined	
Schools visited	14	Venereal disease			Ref. to S.B.H. for prenatal letters	
Cards received	793	Scarlet fever		1	Ref to S.B.H for diet cards	
Children examined	105	**LIFE EXTENSION**			Ref to S.B.H. for preschool advice	
Children treated	2	Applications received		23	Sanitary privies	
Sanitary privies installed		Examinations made		25	**TUBERCULOSIS**	
Physical exam teachers	2	Midwives instructed			New cases	
DISPENSARIES		**COUNTY DEPENDENTS**			Visits made, instructive	
Vaccinations, typhoid		Visits to county home		1	Visits made, nursing	
" smallpox	305	Visits to county jail		3	Demonstrations	
" whooping-cough		Visits to convict camps		1	Conferences, personal	
CITY (Special)		Patients treated		2	Sent to physician	
Inspections, hotels, etc.	6	Treatments given		4	Discharged to sanatorium	
Dairy inspections		Lunacy examinations		1	Discharged cured	
Milk examinations		Physical exam. prisoners		3	Home care only	
Sewer connections	3				Remarks	
Special investigatons	2					
Nuisances abated						

Fig. 70.—Statistical summary of work of county health department for one month. Indicates range of activities undertaken. Southern States

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ACTIVITIES OF COUNTY HEALTH DEPARTMENTS

Fig. 70, page 111, gives a concise statistical summary of the activities of a typical county health department for the month of February, 1920. During the same month there were seventy other county health departments in twelve Southern States engaged in similar activities. It will be seen that attention centers in the prevention of soil pollution and its attending diseases, such as typhoid fever, infant diarrhea, the dysenteries, and hookworm; in life extension work; in the medical inspection and treatment of school children; the quarantine of infectious diseases; the prevention of tuberculosis; and in infant welfare. Effort is made to stress the fundamental principles of healthful living, to develop an accurate system of reporting vital statistics, and to establish at least the nucleus of a public health laboratory service.

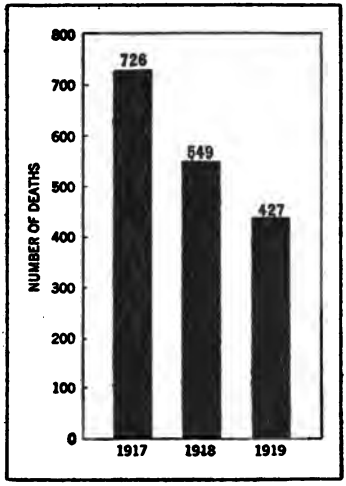


Fig. 71.—Deaths from typhoid fever in North Carolina, 1917 to 1919

Prevention of Soil Pollution. This phase of the work seeks primarily to secure the installation and use of a sanitary latrine at every home. Inspectors of the health department visit the homes throughout the county, make sanitary inspections, and leave behind them plans and specifications for approved latrines. The inspectors later repeat their visits to observe whether the improvement recommended has been made. Their task is simplified in states or communities where there are ordinances requiring the use of latrines; here the inspectors merely see that the law is enforced. The activities against soil pollution also include the making of examinations for hookworm disease and the treatment of those who are found to be infected.

Medical Inspection and Dental Service for Rural Children. The school children of the county are medically inspected in order to obtain a record of the physical condition of every child and treatment for those who need it. The teachers insert on the record card for each child the date of birth, age on entering school, grades repeated (if any), history of diseases in family, the child's height, weight, and chest expansion, the condition of his teeth, eyes, ears, and throat, and the

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Fig. 72.—Preventing pollution of the soil is a leading feature of county health work. Corrugated iron lining for pit latrines, adopted for use in Grenada county, Mississippi. In soils with ground-water level near the surface it is necessary to line the pits

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Fig. 73.—Inexpensive superstructure erected over lined pit. Grenada county, Mississippi

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state of his nutrition. The completed cards are then transmitted to the health officer, who carefully considers each case and examines every child whose card indicates it to possess a remediable defect or abnormality. The examination is made preferably in the presence of the parents, so that the health officer may discuss with them the advisability and the best methods of having the child treated.

The health departments make special effort to educate parents regarding the dangers of dental defects in their children and to impress upon them the importance of having these defects remedied. Traveling dental clinics are provided for rural school children. The great majority of the patients reached by this service are very young children who have never before visited a dentist.

Infant Welfare. This division of the work seeks to lower the death rate among babies and young children by systematically instructing mothers in the principles of infant and child hygiene. The nurse who conducts this unit of work holds clinics at the health office and at other places throughout the county, and gives a course of intensive study to clubs and other women's organizations. Literature for the study course is provided by the state board of health. A clinic conducted by the health officer concludes the course. The nurse arranges to meet the club once a month thereafter for the discussion of community health conditions and for consultations with mothers. She endeavors to give personal instruction to all expectant mothers, to mothers of bottle-fed babies and of babies with diarrhea, and to persons living in homes where tuberculosis exists. She is also charged with supervising and instructing midwives.

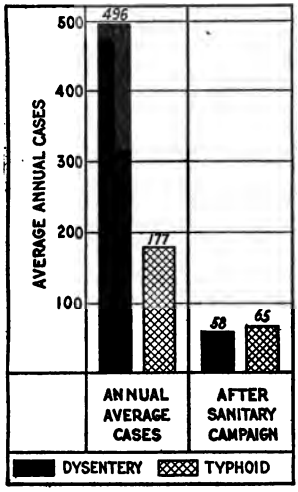


Fig. 74.—Reduction in average annual number of cases of dysentery and typhoid. Situation in Troup county, Georgia, before and after inauguration of county health work compared

Life Extension. The life extension work has proved very popular and has served as a means of enlisting the interest and co-operation of influential citizens. It consists of making thorough physical examinations of adults. The work is intended primarily for persons who are well, and its object is to keep them at their highest state of efficiency. Periodic medical examinations will often detect latent or incipient impairments in health, find minor defects which injure the citizen and decrease his working capacity, and so make it possible

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for him to secure medical attention before the condition becomes serious or permanent. The examinations, which include urine and blood-pressure tests, are made in the health office. Treatment is never given. If medical or surgical attention seems advisable, the patient chooses his own physician. Each person receives, however, oral and printed advice and appropriate health literature.

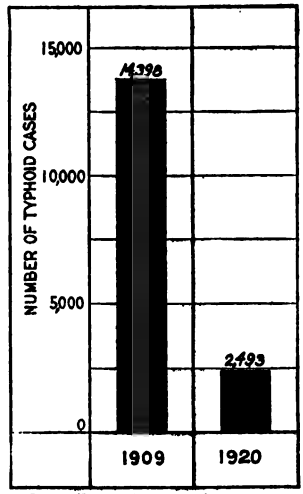


Fig. 75.—Cases of typhoid fever in Virginia, 1909 compared with 1920

Control of Communicable Diseases. This is effected through the state quarantine law, which usually requires the attending physician or the householder to report acute infectious diseases. The health department, upon receiving these reports, sends literature on the disease to the householder and to the school teacher in the district wherein the home is located; and the health officer visits the homes of as many as possible of the cases to give personal instruction in the means of preventing the spread of the disease. Usually the county health office keeps a record of each case reported, transmits notices and detailed monthly reports to the epidemiologist of the state board of health, submits to the newspapers monthly articles on the quarantine work of the county, and publishes in the papers the name and address of each case of communicable disease reported.

EDUCATING THE PUBLIC IN HEALTHFUL LIVING

The work of the county departments always stresses the educational phase. The health officer and his assistants try to present the facts of public hygiene and sanitation in such way that they may benefit every citizen in the county. Lectures and demonstrations, newspaper articles, literature, clinics, and consultations in house-to-house visits form the main channels through which the public is reached. The schools invariably receive special attention, catechisms and similar material on hygienic topics being frequently prepared for use in them. In certain southern counties, as a result of health teaching, the schools have formed organizations to look after the sanitary condition of the school district and to make reports to the health officer.

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Fig. 76.—Anti-plague work, Beaumont, Texas: to the left, rat catcher starting out on daily rounds; to the right, rat catchers returning with their catch. A special activity of a Texas county health department

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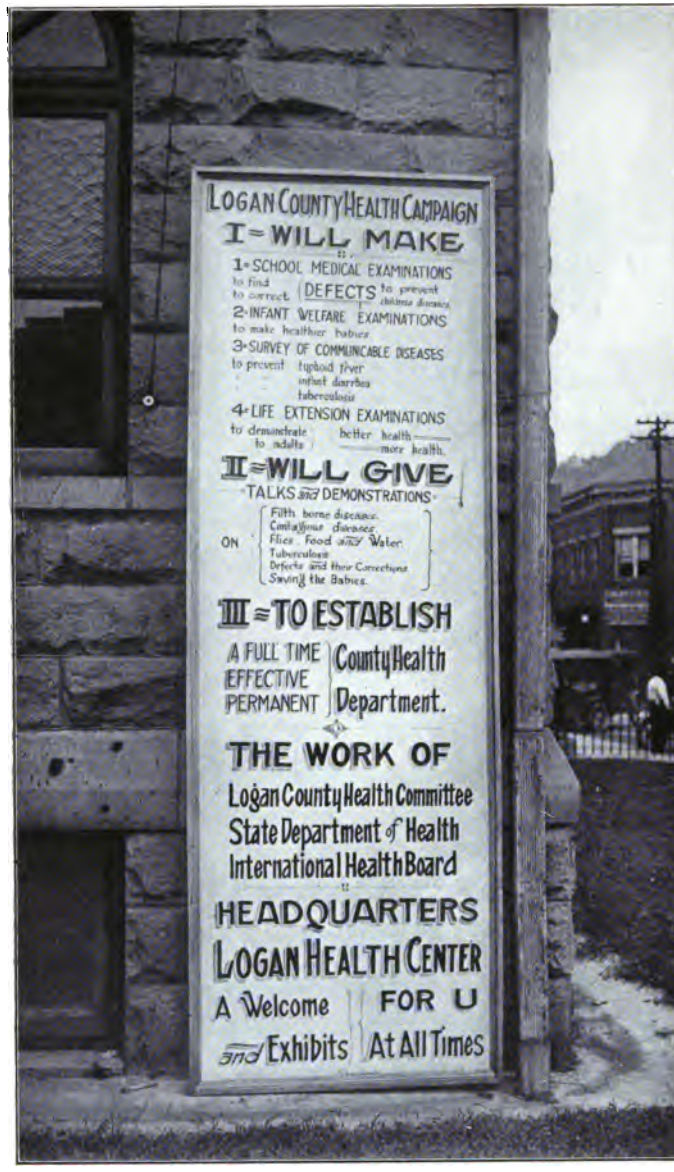


Fig. 77.—Advertising the county health department. Sign board displayed at Logan, the county seat of Logan county, West Virginia

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Other publicity devices which have been used with much success consist of health slogans painted on mileposts on the county highways, of weekly bulletins distributed through the county, of letter seals for the use of the department of health, and of exhibits at the county fairs. When the milepost sign is used, two advertisements on each post defray the cost of erecting the posts. In certain instances a contest is held to secure effective sentences for use as slogans. When this is done the business men of the county sometimes agree to furnish the necessary prizes; and men, women, and children in every part of the county take part in the contests. By means of the signs it is possible not only to foster county pride and spirit, to aid visitors, and to advertise the merchants of the county, but also to drive home through repetition the need of preventing disease and the methods by which this may be accomplished.

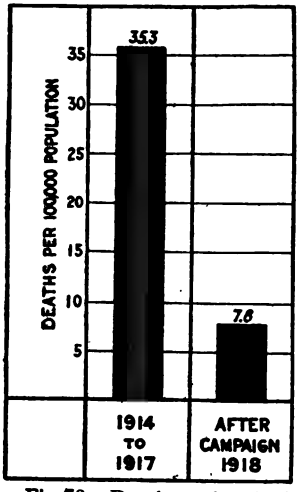


Fig. 78.—Deaths per hundred thousand from typhoid fever, before and after inauguration of county health work. Nine North Carolina counties

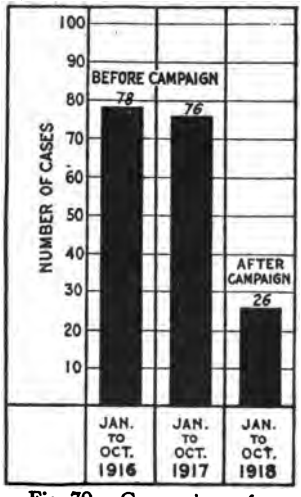


Fig. 79.—Comparison of typhoid cases before and after county health work. Wicomico county, Maryland

REDUCTION IN INCIDENCE OF DISEASE

The most direct evidence of the effectiveness of county health work is to be found in the lowering of sickness and death rates. In North Carolina the number of cases of typhoid fever was reduced from 726 in 1917 to 427 in 1919. This represents a decrease from 29.6 to 16.9 per 100,000 in the typhoid death rate. For each death from typhoid fever it is estimated that there are on the average ten cases, and each case is

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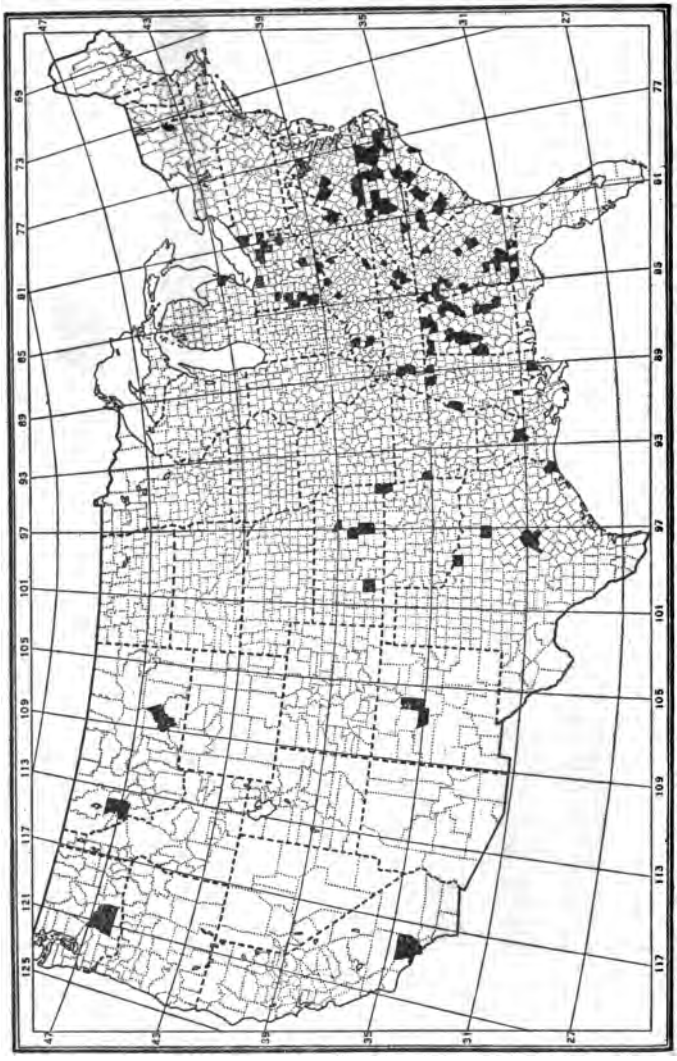


Fig. 80.—Counties or rural districts of United States having health departments with a whole-time health officer in charge. On December 31, 1920, there were 126 of these departments in the country

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estimated to cause a loss to the state of not less than $400. In Monroe county, Mississippi, where 8,465 persons were inoculated for typhoid fever between 1918 and 1920 and a total of 1,811 sanitary privies were installed during the same period, the typhoid cases in 1920 numbered 89.8 per cent less than in 1917. Figs. 18, 71, 74, 75, 78, and 79, pages 31 and 112 to 119, depict graphically the reduction in various diseases that has occurred in states in which county health work has been conducted.

EXTENSION OF WORK TO OTHER STATES

The plan of work in operation in the Southern States is applicable to other sections as well. It is, in fact, already being adopted by states in other sections. There were in the country on December 31, 1920, not less than one hundred twenty-six rural counties or districts having county health departments each with a whole-time health officer (Fig. 80, page 120). Kansas and New Mexico are among the latest states to establish such departments.

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TABULAR SUMMARY

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TABLE 1: All Countries—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Geographical Regions. Figures Excluded for Areas in Which Work Was Still in Progress

Geographical Region	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	..	..	..	..	..	**292,567**	..	**189,628**	**64.8**
Southern States[1]	..	19,460	..	5,688	29.2	6,471[2]	..	22	0.3
West Indies	29,138	28,890	99.1	16,067	55.6	15,274	95.1	12,867	84.2
Central America[3]	164,654		85.2	78,580	56.0	67,963	86.5	31,093	45.7
South America	120,366	110,192	91.5	84,406	76.6	74,400	88.1	49,330	66.3
The East[4]	..	..	..	..	..	128,459	..	96,316	75.0

[1] During 1920, in the Southern States, the main emphasis in work against soil pollution diseases was placed on the building and improving of latrines.

[2] Some of the persons treated were found infected during 1919.

[3] In Central America the bulk of the work is by the dispensary plan. This does not afford opportunity for frequent re-examinations to determine cure. Consequently the percentage of persons known to be cured is low in comparison with that for other regions.

[4] In Ceylon, throughout 1920, estate laborers were assumed to be infected, and accordingly were given first treatment without preliminary microscopic diagnosis. This explains the blank spaces for "Census," "Microscopically Examined," and "Found Infected" in the lines for "The East" and "Total."

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TABLE 2: Southern States—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by States. Figures Excluded for Areas in Which Work Was Still in Progress[1]

State	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	..	**19,460**	..	**5,688**	**29.2**	**6,471**[2]	..	**22**	**.3**
Alabama	..	504	..	381	75.6	516	..	8	1.2
Georgia	..	397	..	236	59.4	236	100.0	..	..
Mississippi	35,724	13,943	39.0	4,452	31.9	4,452	100.0	2	[3]
South Carolina	..	3,408	..	578	17.0	1,237[2]	..	..	..
Tennessee	9,928	644	6.5	28	4.3	20	71.4	5	25.0
Texas	467	257	55.0	12	4.7	9	75.0	6	67.7
Virginia	2,839	307	10.8	1	0.3	1	100.0	1	100.0

[1] During 1920, in the Southern States, the main emphasis in work against soil pollution diseases was placed on the building and improving of latrines.

[2] Some of the persons treated were found infected during 1919.

[3] Less than one-tenth of one per cent.

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TABLE 3: West Indies—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress

Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	**29,138**	**28,890**	**99.1**	**16,067**	**55.6**	**15,274**	**95.1**	**12,867**	**84.2**
Jamaica	13,889	13,748	99.0	3,915	28.5	3,605	92.1	3,203	88.8
St. Lucia	6,401	6,373	99.6	4,743	74.4	4,656	98.2	4,261	91.5
Trinidad	8,848	8,769	99.1	7,409	84.5	7,013	94.7	5,403	77.0

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TABLE 4: Central America—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress

Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured[1]	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	164,654	140,318	85.2	78,580	56.0	67,963	86.5	31,093	45.7
Costa Rica	43,134	36,454	84.5	10,743	29.5	8,966	83.5	4,768	53.2
Guatemala	22,887	21,460	93.8	12,805	59.7	11,429	89.3	6,777	59.3
Nicaragua	45,160	33,128	73.3	25,272	76.3	22,035	87.2	8,395	38.1
Panama	14,392	13,104	91.1	10,050	76.7	8,353	83.1	4,009	48.0
Salvador	39,081	36,172	92.6	19,710	54.5	17,180	87.2	7,144	41.6

[1] In Central America the bulk of the work is by the dispensary plan. This does not afford opportunity for frequent re-examinations to determine cure. Consequently the percentage of persons known to be cured is low in comparison with that for other regions.

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TABLE 5: South America—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress.

State and Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	**120,366**	**110,192**	**91.5**	**84,406**	**76.6**	**74,400**	**88.1**	**49,330**	**66.3**
Brazil	112,488	103,329	91.9	78,363	75.8	68,706	87.7	44,977	65.5
Federal District	18,163	16,961	93.4	11,579	68.3	10,583	91.4	5,179	48.9
Minas Geraes	12,563	11,534	91.8	5,068	43.9	4,632	91.4	2,866	61.9
Paraná	24,506	22,410[1]	91.4	17,329[1]	77.3	14,486	83.6	9,391	64.8
Rio de Janeiro	31,897	28,814[2]	90.3	25,626[2]	88.9	22,672	88.5	15,471	68.2
São Paulo	25,359	23,610	93.1	18,761	79.5	16,333	87.1	12,070	73.9
Colombia	7,878	6,863	87.1	6,043	88.1	5,694	94.2	4,353	76.4

[1] Includes 3,178 not required to submit specimens but examined for treatment.
[2] Includes 7,011 not required to submit specimens but examined for treatment.

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TABLE 6: The East—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress

Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total[1]	..	..	..	..	..	**128,459**	..	**96,316**	**75.0**
Australia	5,190	5,008	96.5	350	7.0	345	98.6	305	88.4
Ceylon[1]	..	..	..	..	..	117,337	..	95,302	81.2
Seychelles	1,529	1,525	99.7	902	59.1	853	94.5	685	80.3
Siam	23,091	12,591	54.5	10,216	81.1	9,924	97.1	24	0.2

[1] In Ceylon, throughout 1920, estate laborers were assumed to be infected, and accordingly were given first treatment without preliminary microscopic diagnosis. This explains the blank spaces for "Census," "Microscopically Examined," and "Found Infected" in the lines for "Ceylon" and "Total."

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FINANCIAL STATEMENT

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TABLE 7: Expenditures of the International Health Board Covering its Activities During the Year 1920

Fields of Activity		Amount Expended
Grand Total		**$1,658,269.66**
Relief and Control of Hookworm Disease		623,804.86
Malaria Control		132,118.67
Yellow Fever Control		139,757.40
Tuberculosis in France		518,013.51
Public Health Education		68,553.35
Field Staff Salaries, Expenses, etc., not Prorated to Specific Budgets		25,917.60
Miscellaneous		58,632.07
Administration		91,472.20
Itemization by States and Countries		
Relief and Control of Hookworm Disease		623,804.86
Southern States		144,201.84
West Indies		62,025.73
Central America		97,304.00
South America		206,425.84
The East		113,847.45
Southern States	$144,201.84	
Administration	6,032.20	
Alabama	17,256.72	
Georgia	4,525.39	
Kansas	4,494.00	
Kentucky	16,599.03	
Mississippi	20,709.72	
New Mexico	957.04	
North Carolina	10,463.00	
South Carolina	17,210.63	
Tennessee	13,533.22	
Texas	14,723.99	
Virginia	14,965.17	
West Virginia	2,731.73	
West Indies	62,025.73	
Administration	6,039.23	
British Guiana[1]	486.37	
Dutch Guiana[1]	738.34	
Jamaica	18,400.09	
Porto Rico	7,823.35	
Santo Domingo	1,077.07	
St. Lucia	11,444.57	
Trinidad	16,016.71	

[1] For administrative reasons, British and Dutch Guiana, although on the mainland of South America, are considered West Indian Colonies.

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TABLE 7: Expenditures of the International Health Board Covering its Activities During the Year 1920—Continued

Fields of Activity		Amount Expended
Relief and Control of Hookworm Disease—*Continued*		
Central America	$97,304.00	
Administration	7,178.01	
Costa Rica	20,219.60	
Guatemala	17,126.43	
Nicaragua	18,745.12	
Panama	20,061.02	
Salvador	13,973.82	
South America	206,425.84	
Brazil	193,560.95	
Colombia	12,864.89	
The East	113,847.45	
Administration	7,178.01	
Australia	35,417.31	
Borneo	3,106.23	
Ceylon	34,154.28	
India	7,810.00	
Mauritius	5,688.56	
Seychelles Islands	4,643.03	
Siam	15,850.03	
Malaria Control		$132,118.67
Southern States		121,652.24
Foreign Countries		10,466.43
Southern States	$121,652.24	
Administration	6,032.20	
Alabama	8,906.92	
Arkansas	7,048.90	
Georgia	1,230.86	
Louisiana	30,699.94	
Mississippi	27,537.43	
North Carolina	7,526.13	
South Carolina	13,942.74	
Tennessee	1,969.94	
Texas	11,472.34	
Virginia	5,284.84	
Foreign Countries	10,466.43	
Ecuador	4,595.59	
Nicaragua	425.66	
Porto Rico	5,445.18	

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TABLE 7: Expenditures of the International Health Board Covering its Activities During the Year 1920—Continued

Fields of Activity	Amount Expended
Yellow Fever Control	$139,757.40
Epidemic work	23,539.03
Ecuador	28,574.98
Salvador	3,926.26
Expenses of Investigating Commissions and salaries, expenses, etc., of Director and Associates	83,717.13
Tuberculosis in France	518,013.51
Central Administration	86,310.57
Medical Division	80,226.08
Public Health Visitation	76,191.46
Educational Division	135,920.64
Departmental Organization	139,364.76
Public Health Education	68,553.35
Department of Hygiene—Faculdade de Medicina e Cirurgia de São Paulo Operating Expenses	30,143.51
Fellowships	38,409.84
Miscellaneous	58,632.07
Conference of State Health Officers	2,488.71
Conference of Malaria Workers	1,810.35
Czechoslovakia—Public Health Work	12,708.81
Drugs for Conserving Health of Field Staff	32.29
Express, Freight, and Exchange	557.85
Field Equipment and Supplies	5,996.96
Investigation of Scientific Preparation and Preservation of Powdered Milk	500.00
Medical Examination of Applicants for Field Staff	125.00
Motion Picture Film on Hookworm Disease	2,817.73
Pamphlets and Charts	5,873.33
Paris Conference on an International Nomenclature of Causes of Death	615.30
Repainting Office at Salvador	75.00
Surveys and Exhibits	23,528.78
Survey—Public Health Administration in Massachusetts	1,467.27
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